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WATERSHED PRIORITIZATION ON USING REMOTE SENSING AND GIS TECHNIQUES - A CASE STUDY OF BANDAL WATER-SHED, DEHRADUN DISTRICT, UTTARANCHAL

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Introduction

Soil and water are of crucial importance for mankind. These are nature's gift to us. The continuing and accelerating depletion of the availability of these resource is a matter of grave concern. Due to enormous increase in population has created many problems deforestation, faulty cultivation, over grazing, changing, changing life style and increased pressure of urban population on land. Thus continuous degradation of production base and imbalance in land-water-plant-human-animal system is leading to ecological imbalance and economic in security through sever soil erosion.

It is estimated (Das 1992), that out of total reported geographical area 329 million hect-ares, about 167 mha (51% of the total area) are affected by serious problem of which 127 mha are affected to serious soil erosion and 40 mha are degraded are through gullies, and ravines, shifting cultivation, water logging, salinity, alkalinity etc. In a recent analysis of annual soil erosion rate in India (Dhruva Narayan and Ram Babu 1983), it was estimated that about 5334 million tonnes (16.35 ton/ha) of soil is detached annually due to agriculture and associated activities alone. The country's rivers carry about 2052 million ton (6.26 ton/ha); of this and nearly 1572 million ton (29% of the total eroded soil), are carried away by the rivers into the sea year and 480 million ton (10% of the total eroded soil) are being deposited in various reservoirs resulting in considerable loss of the storage capacity.

Therefore, at present time the most attention is giving on soil erosion problem. The devel-opment of recent technologies e.g. Remote Sensing and Geographical Information System are very useful for management of water resources Scientific management of soil and water resources on watershed basis is, therefore very important to arrest rapid soil erosion watershed basis scien-tific management requires a good database of watershed such as watershed boundary, drainage map, various watershed characteristics, accurate and reliable observed runoff and sediment yield data. Satellite Remote sensing provide us scientific inputs for formulation of appropriate watershed management programs and parameters related to watershed development. Many parametric meth-ods have been developed to estimate soil erosion. The most commonly used method for estima-tion of soil loss is Universal Soil Loss Equation (USLE) presented by Wischmeier (1959) in USA.

This equation can be modeled in graphical information system environment. Various factors can be determined by using Remote sensing and GIS. In this project map we got the priority class of each subwatershed after crossing landuse/landcover map, Hydrologic soil group map and classified slop map.

Study Area

The Bandal Watershed lies in the north eastern portion of the State of Uttaranchal from 30°20'20' to 30°26'59' N latitude and 78°07'42" E to 78° 16' 44" E longitude and main stream from boundary between the Tehri Garhwal and Dehradun districts. The area is covered by SOI topographical map No. 53J/3 and 53 J/7 on 1:50,000 scale, with a total area about 82.21 Sq. Km. The study area is accessible from Dehradun as well as Mussorie. The area is covered 96/49 & 46/50 of IRS IC LISS III sensors.

The area depicts a rugged consisting of structural hills, educational hills gently sloping piedmont zone bounded by Lesser Himalayas in the North and Shiwalik in the South. In between these two Northern and Southern hill ranges lies the Doon valley, comprising mostly of piedmont zone and alluvial plains. Within the study area the hills of Lesser Himalayas in the North rise to an average elevation of 2000 m above m.s.l. Piedmont rise upto an elevation ranging from 500 to 700 m above m.s.l., and alluvial plain have an elevation ranging from 300 to 500 m above m.s.l. Physiographical the area is composed of Mountains (steep to very steep slope), Hills (steep hills and moderately steep hills), Piedmont plains, River terraces & Flood plains.

The drainage system of the study area is a part of Ganga System. The main tributaries of Ganga are Song, Suswa, Jakhan Rao and Chandrabhaga river. Banal river is the tributary of Song river. The river shows a braided pattern. The drainage pattern of the study area is of dendritic type with some local variations at places. (Bali Y.P. 1983)

Geology of the study area comprises of phyllites and shale's (quartzite form) and alluvium. The drainage pattern is dendritic type with some local variations at places. There is no sharp or abrupt stream. The deposition by river at the lower side formed alluvial terrain comprises of old and recent flood plains. Doon valley is intermontane valley surrounded by Lesser Himalayas in the North and Shiwalik ranges in the South.

The watershed comprises of soils falling in the orders of Entisols, Inceptisols, Alfisols and mollisols. Most of the soils are netural to acidic. The soils are well drained and in most cases depth of soils varies between deep to very deep underlain by stones, boulders, sand and silty strata.

The climate of study area is subtropical characterized by mind summer and serve cold winter. The average annual rainfall of the area is 2000 mm and more than half of the annual rainfall is received during July August. The mean summer and winter temperature.

Material and Methods

Material used:

Applying the technique of Remote Sensing and Geographical Information System, the following data and materials were used.

1. IRS-IC LISS III FCC on 1:50,000 Scale
2. IRS IC LISS III (digital data) of Feb. 1997
3. SOI Toposheet No. 53/J3, 53/J/7 on 1:50,000 scale
4. Collaterial data
5. ILWIS 2.23 software
6. Meteorological data

Landuse and Land Cover classification:

Landuse map was prepared by supervised classification. Remote sensing data is affected by many distortion when an image is created it is stored in row and column in raster format. This image dose not georeferecing is done to establish the relationship between row and column of image and real world.

In general, two approaches can be followed:

i. Geo-reference: Specifying the co-ordinates of the lower left and upper right corner of the raster image plus the actual pixel size in the case these are known

ii. Geo-reference tie points: Specifying reference points that relate for distinct points their row/column number with the corresponding x/y co-ordinate. In this work tie points methods was used.

After georeferencing, each time a pixel is addressed in the display window the corresponding x,y coordinate is returned, but its geometry in not corrected for geometric distortions and not adapted to a master image. To create a distortion free adapted image, the transformation that is defined during georeferencing is executed. This process, geocoding, results in a new image in which pixels are arranged in geometry of the master image, and the resolution is equal to the resolution of the master image or chosen in case the master is a topographic map. The radiometric values or pixel values of the new image are found by resampling the original image using a chosen inter polation methods. There supervised classification has been carried out to prepare the landuse map of the study area.

Each classifier used a sample set, in the present study; best result has been obtained by maximum likelihood classification. Using this study area has been area has been divided into following Landuse/Landcover classes.

i. Dense forest
ii. Moderate forest
iii. Open forest
iv. Cultivation
v. River bed
vi. Water body
vii. Settlement

Field Work/Check

Field Work was undertaken in order collect ground truth information initially rapid reconnaissance survey of the study area was carried out during field check different mapping units and their boundaries were verified necessary correction were done. Sample of various features were also selected for supervised classification

Methodology

Prioritization of watershed:

There is a growing need to analyse the watershed for their response towards soil erosion under varying conditions of vegetation and climate. The natural hydrologic processes like erosion of soil, movement of soil and its deposition in various parts of reservoir are very crucial phenomena occurring in any watershed. Land and water management on watershed basis has a scientific proven base. Which helps in reducing soil erosion, increasing productivity along with proper and sustainable utilization of resource.

There are basically three types of erosion models; empirical, conceptual and physically based. Empirical models are base on inductive logic, and generally applicable only to those conditions for which the parameters have been calibrated. In this project following methodology is carried out. All process has done through ILWIS software.

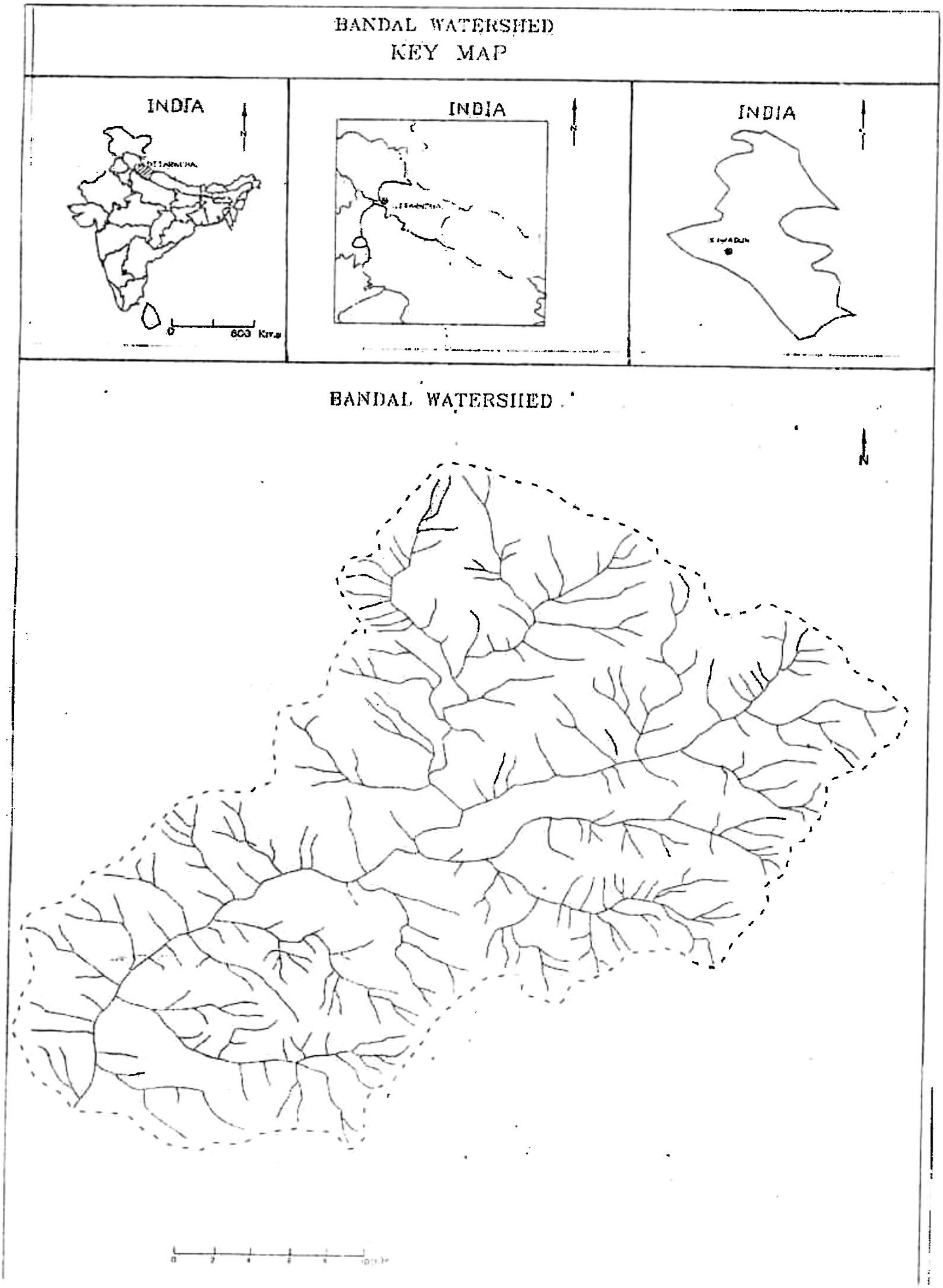
- **DEM, Slope and Aspect maps:**

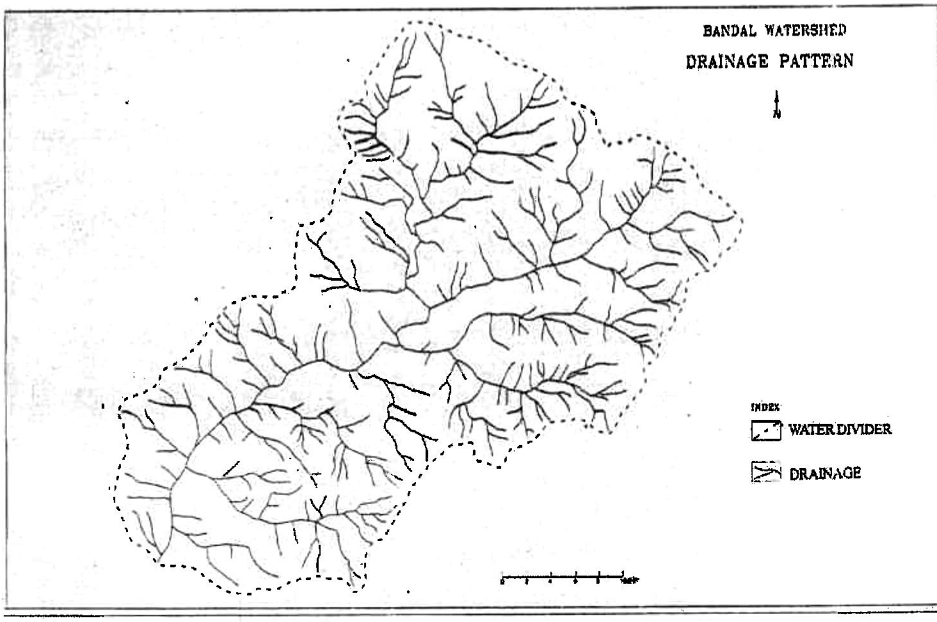
First a contour segment map was prepared by on screen digitization over the colour scanned SOI topographical maps. A point map showing the spot heights at various locations was prepared and rasterised. After completion of contour map digitization, it was interpolated for getting digital elevation model (DEM). The output of the contour interpolation is a raster map in which each pixel in the map has height value. The interpolation method is based on the Borge fors distance method. Slope map was created by applying dfd(dx) and dfdy(dy) filters. Following was used to calculate slope map(in%)

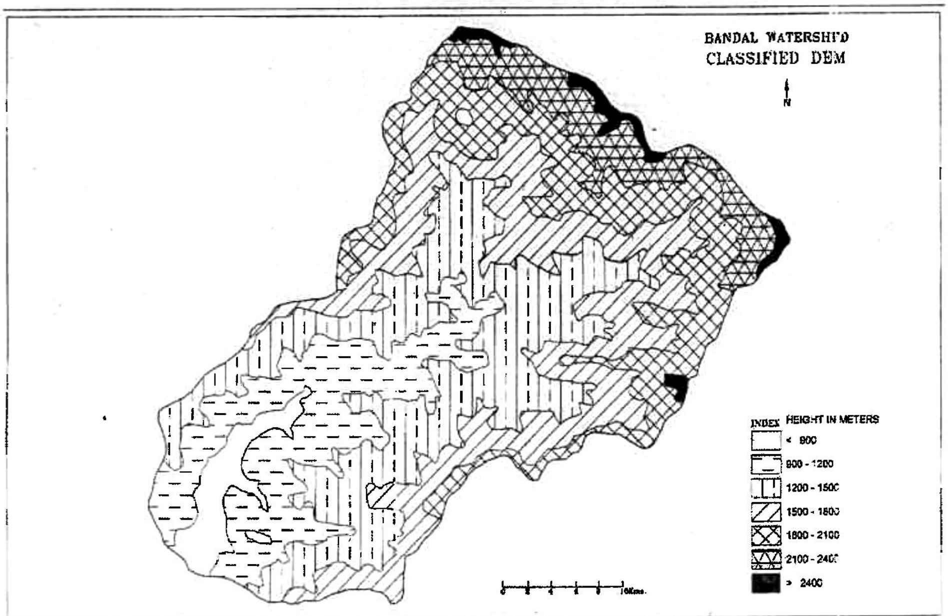
Slope = (hyp(Dx, Dy)/Pixel Size)*100

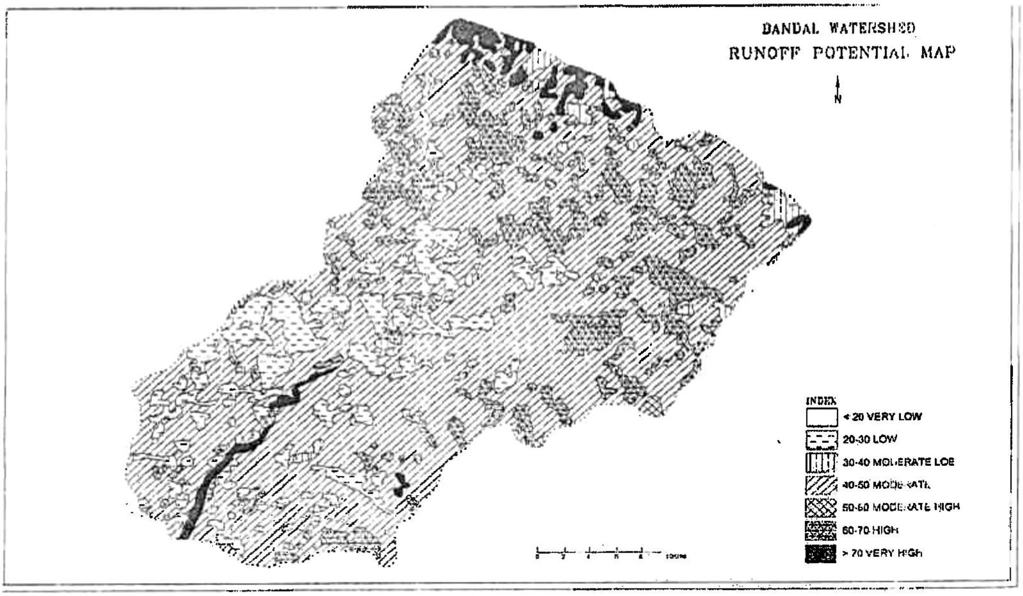
For getting slope in degree following formula was applied

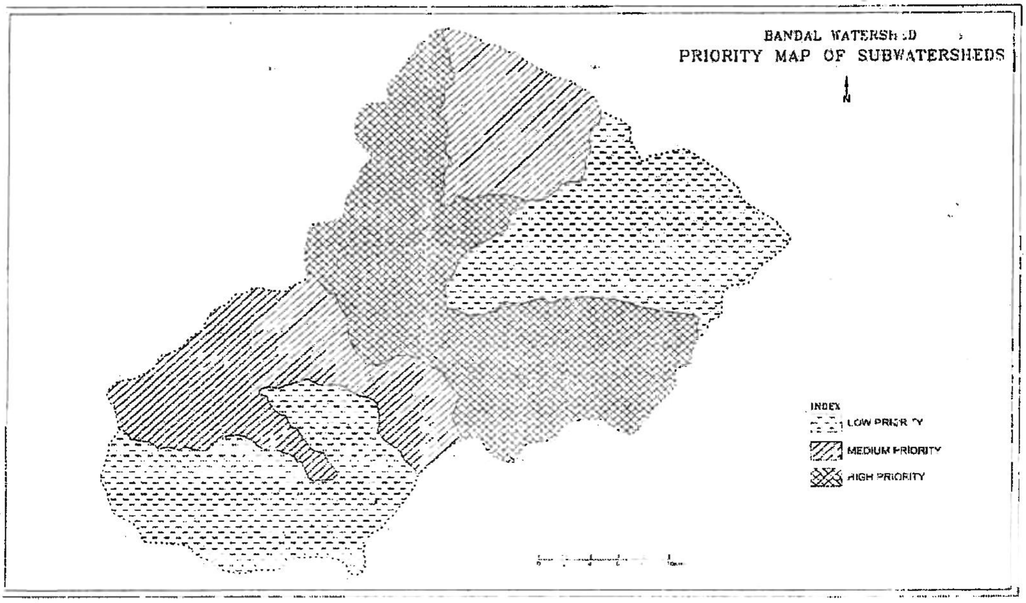
Slope map was further classified into 7 classes according to IMSD parameters are following:


BANDAL WATERSHED
KEY MAP
INDIA
INDIA
INDIA
0
600 Km.s
BANDAL WATERSHED
N


BANDAL WATERSHED
DRAINAGE PATTERN
N
INDEX
WATER DIVIDER
DRAINAGE


BANDAL WATERSHED
CLASSIFIED DEM
N
INDEX HEIGHT IN METERS
< 900
900 - 1200
1200 - 1500
1500 - 1800
1800 - 2100
> 2400


BANDAL WATERSHED
RUNOFF POTENTIAL MAP
N
INDEX
< 20 VERY LOW
20-30 LOW
30-40 MODERATE LOE
40-50 MODERATE
50-60 MODERATE HIGH
60-70 HIGH
> 70 VERY HIGH


BANDAL WATERSHED
PRIORITY MAP OF SUBWATERSHEDS
N
INDEX
LOW PRIORITY
MEDIUM PRIORITY
HIGH PRIORITY

- Nearly level (<1)
- Very gently sloping (1-3)
- Gently sloping (3-5)
- Moderately sloping (5-10)
- Strongly sloping (10-15)
- Steep sloping (13-35)
- Very steep sloping (>35)
- Aspect map was generated (in % and degree) using following command:
- Aspect: RADDEG(ATAN2(Dx,Dy)+Pi)
- **Drainage and Subwatershed Map:**

The colour scaned SOI topographical map was used as the base for on screen digitization of the drainage lines of watershed which is to be used in analysing the morpho-metric parametress of the subwatersheds. The subwatershed boundaries were also digitized on screen with the help of drainage and contour maps.

- **Landuse/Landcover, Soil association and H.S.G. maps**

Landuse/Landcover map is created after supervised classification from IRC IC LISS III digital data (Feb. 1997). For creating soil association map three maps namely landuse, aspect and classified DEM were crossed we have crossed three maps, landuse, Aspect and classified DEM. We got four soil associations eg. CL/LS,FL/LS, LS/FL,LS/LS. Nsmely:

(1.) Clay loam, (2.) Loamy sand, (3.) Fine loam

H.S.G. map was created after reclassing soil association map HSG map classified in to three groups eg. A.B.C.

- **Weighted map:**

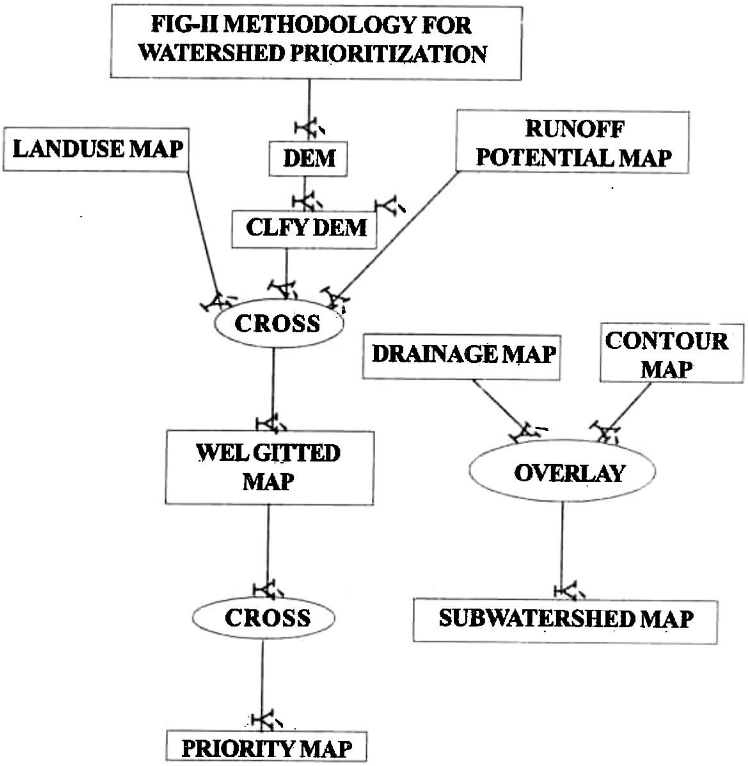
Weighted map was prepared after crossing landuse map. LISG map and classified slope map. Weight were given according to landuse, slop and Hydrologic Soil Groups. After giving weight age prepare weighted map through attribute data handling work.

- **Priority Map:**

Priority map was created after reclassifying weighted map.

Results and Conclusion

Sustainable development of watershed is possible after soil and water conservation in any watershed on priority basis. The priority classification of subwatershed helps in taking up soil conservation measures on a priority basis. Weighted values obtained from landuse, slope and



HSG groups and these attributes considered for watershed prioritization are slope, surface condition and present landuse.

The finding of the study are listed below

- The subwatershed 1and 3 which accounts for 13.02% of total area falls in the very high class. It has been in these class the W factor value are on high land cover is poor.
- The subwatersheds 4 and 11 comprising of 31.29% of watershed comes under high priority class. In these subwatersheds it has been observed that the upper sides of those are highly dissected.
- 29.14% of watershed comes under moderate priority class. This class comprises of 5,7 and 2 No. subwatersheds comparatively less soil erosion is due to better land cover and moderate slope.
- The subwatersheds 6 and 9 come low priority class and covers 11.15% of the water shed. These units have very good vegetation cover.

- The subwatershed 8 and 10 falls in very low priority class these units' accounts for 14.00% of the watershed.
- The discharge from Bandal watershed is 217.16 mm.

The present study was carried out in Bandal watershed which is located in Dehradun district of Uttaranchal. It occupies 82.21 sq. km. The range of range of elevation in the study area varies from 700-2600 mts.

The study area has been divided in seven landuse/landcover classes: Dense forest, Moderate Forest, Open forest, Cultivation, River bed water body and Settlement. The bandal watershed divided into 11 subwatersheds. Out of the total study area it was found out that 24.40% falls under high classes while 57.23% of the area falls under moderate priority class. Only 18.27% of the total area comes under low priority class. Hence it can be said that now some correctives measures should be taken before the problem assumes dangerous proportions.

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