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LAND USE/LAND COVER MAPPING OF BAIRA NALLA SUB-CATCHMENT ABOVE TISSA (HP)

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PREFACE

Land cover is an intrinsic part of the ecosystem and as such it forms an important parameter in hydrological modelling. Various hydrological processes such as interception, infiltration, evapotranspiration, soil moisture and ground water recharge are influenced by land use/ land cover characteristics of a watershed. Remote sensing technology has immense potential to obtain Land use/ land cover information with certain degree of reliability.

The National Institute of Hydrology started long term hydrologic studies in the representative basins of hydrologically similar regions of the country. One of such studies has been taken up by the NIH Regional Centre at Jammu for Baira nalla sub catchment above Tissa in the District of Chamba (HP). The study has been conducted using standard false colour composites of IRS-1B (LISS-II) data. The visual interpretation technique was adopted to decipher various land use/ land cover types based on various aspects such as tone/ colour, shape, size, texture and other features of the image interpretation. The study would be useful to undertake various hydrological studies and to implement watershed development programmes for sustainable development of the region.

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(S M SETH)

DIRECTOR

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ABSTRACT

Land use/land cover exerts considerable influence in determining various hydrological phenomena such as infiltration, overland flow, evaporation and interception. Various aspects of hydrologic studies can be undertaken if information on land use/land cover are available. In the present study land use/land cover map of Baira nalla sub catchment above Tissa (HP) has been prepared using false colour composite of IRS-1B (LISS-II) data for the period of 13th October, 1993. The Survey of India Topographical maps and photographs were used as ancillary information in the present study. The satellite imageries have been visually interpreted based on various aspects of image interpretation for remotely sensed data.

Five land use/ land covers could be deciphered in the present study. These are agricultural land, forest, barren/ rocky land, degraded/ scrub land and perennial snow. The present study have showed that total sub catchment area accounts for 38.15% agricultural land, 33.39% forest land, 17.23% barren/ rocky land, 10.77% degraded/ scrub land and 0.45% perennial snow. It is evident that major area in the sub catchment is under agricultural activities. Severe land slips and erosion problems are dominating in the study area. Land degradation is due to biotic and abiotic disturbances caused to forested lands.

The study has showed that there exist a wide scope for undertaking hydrological studied in the area. Watershed management programmes should be implemented to conserve the soil and water resources of the region for sustained productivity to assure a sound socio- economic development of the people in this area.

1.0 INTRODUCTION

Land is the most important natural resources on which all man's activities are based. The growing pressure of population and human activities are increasing the demand on the limited land and soil resources for agriculture, forest, pasture, urban and industrial land uses. Information on the rate and kind of changes in the use of land resources is essential for proper planning, management and to regularise the use of such resources (Gautam, 1983). Knowledge about existing land use and land cover and trends of change is essential for obvious reasons(Kundalia and Chennaiah, 1978). Land use data are also needed in the analysis of environmental processes and problems, that must be understood of if living conditions and standards are to be improved or maintained at current levels (Anderson et al 1971).

The term land use relates to the human activity associated with a specific piece of land. The term land cover relates to the type of feature present on the surface of the earth. Urban building, lakes, glacial ice etc. are all examples of land cover types. Land cover of any area may be evergreen forest, out of the land use may be lumbering, recreation, wild life sanctuary or various combinations of activities.

The land use change have a direct bearing on the hydrologic cycle are realized from the point the precipitation reaches the earth surface. Various hydrologic processes such as interception, infiltration, evapotranspiration, soil moisture, runoff and ground water recharge are influenced by land use/land cover characteristics of the catchment.

Land use/land cover are dynamic features over space and time. Therefore it is difficult to get real time information through conventional means. On the other hands, an optimum land use planning strategy needs timely, accurate and up to date information on

land use on the shortest possible time. Until recently the most common remote sensing methods available for land use and land cover mapping has been interpretation of aerial photographs (Ellefsen et al., 1977). For the past twenty years remotely sensed satellite borne multi spectral imagery have become increasingly used for land use and land cover mapping (NRSA, 1978, 1979a,b; 1982). Satellite remote sensing technology offers an efficient and timely data to map not only the current land use/land cover distribution and pattern, but also to monitor such changes/trends in land use/land cover over a period of time (Nagaraja et al., 1982).

In this study an attempt has been made to prepare land use map of Baira Nalla Sub Catchment located above Tissa, District Chamba (H.P.).

2.0 REVIEW

2.1 Definition of Land Use/Land Cover

Land use refers to "man's activities and the various use which are carried on land". (Clawson & Stewart, 1965). Land cover refers to "natural vegetation, water bodies, rock/soil, artificial cover and others resulting due to land transformation.

The terms land use and land cover are closely related and interchangeable. The purpose for which land is being used, commonly are associated with different types of cover such as forest, agriculture, wasteland or water bodies.

2.2 Land Use/ Land Cover Classification

Classification is nothing but to put similar things together and non-similar things together. In other words "classification is the grouping of subjects into classes on the basis of properties and relationship they have in common". Thus each land use category should be homogeneous in nature. It depends upon the region which is being studied and number of land use classes of units that are being analyzed.

2.3 Characteristics of a Land Use/Land Cover Classification System

It includes the following points:

(a) The land use/land cover classification should deal primarily with man's activities on land. Non activity information can be included at a later stage (Clawson,1965).

(b) The classification should be flexible to be adopted at any given region with in the country, in terms of level for details (Anderson et al. 1976).

(c) Classification should be based on what is observed on the land. Minimum meaningful

groupings should be made.

(d) Field work should be planned based on the smallest mappable unit which varies according to scale.

(e) It should be adaptable both by visual interpretation and digital analysis of land use and land cover categorization on different scales.

(f) The classification system should be compatible with the existing system.

2.4 Remote Sensing as Related to Land Use/Land Cover

In this connection following points should be kept in mind while using satellite data for land use/ land cover studies:

(a) Land use cannot be read directly from satellite imagery. Therefore, it has to be inferred from the land cover seen in the area.

(b) Land use /land cover categories (nomenclature) should be clearly defined to avoid confusion of interpretation from one scientist to another scientist.

(c) Geographic configuration and size of similar Land use/ land cover categories varies from one place to another. Hence, interpretation details also vary from place to place.

(d) Land use is a dynamic phenomena and it changes from one season to another. Therefore, terrain appearance also vary from season to season.

(e) Level of information on the land use obtainable on an imagery is dependent on scale and spatial resolution of the satellite data.

2.5 Criteria for Land Use/ Land Cover Classification

To develop any land use/land cover classification system it is essential to consider certain criteria and limitations of satellite data and study area pertaining to Indian

conditions, as any classification system using satellite data should provide a frame work to satisfy the needs of the majority of users. For this certain guidelines and criteria for evolution must be established.

(a) The land use and land cover classification system involved should be applicable over large area.

(b) The classification should be suitable for using satellite data obtained at different periods of the year.

(c) Assemble of land use/ land cover categories must be possible.

(d) The minimum interpretation accuracy and reliability in the identification of land use/ land cover categories from satellite data should be at least 85% to 95%.

(e) Due to small scale of satellite imagery certain land use/ land cover categories may be generalized. For example land use such as agriculture and different crops can be put together under main head agriculture.

(f) Acquisition of data should be planned on the basis of dominant use of levels of detail. For most purposes imagery obtained in Kharif and Rabi seasons would be ideal for land use mapping. To decide on an appropriate classification, or category level with in a classification, an arbitrary decision must be made. One must decide on imagery scale or on the scale of representation of data. Data based on scales of 1:1 million, 1:250,000 and 1:50,000 will serve the present levels viz., Level-I, Level-II and Level-III classification respectively.

2.6 Limitation of Satellite Data

The following limitations exist with satellite:

(a) Recreational activities covering large area of land are not easily amenable to

interpretation from satellite data.

(b) Identifying and classifying multiple uses occurring on a single parcel of land will not be so easy.

(c) Cities and big towns are broad means of communication can be identified and classification according to the classification under different levels.

(d) Ground resolutions of various present satellites vary from 10 to 80 meters.

(e) The land use/land cover categories cannot be identified with level of accuracy on the size of the smallest unit. On the other hand specific land use can be identified which are too small to be mapped. For example small villages and some times big towns are not distinguished from agriculture land use when mapped at the more generalized level of classification.

(f) The spectral signature of two different objects sometimes may appear similar and create a lot of problems to the interpreter while analyzing the images. For example hill shadow and water bodies are mixed together because of their dark tone and texture particularly in digital analysis.

(g) Broad land use categories can be identified because of limitation on the resolution and scale of the satellite data.

2.7 Levels of Classification Using Satellite Data

The National Land Use/ Land Cover Classification system was designed as a reconnaissance scheme applicable in Indian environment with varying needs and perspectives. The land use/ land cover categories can be expanded or reduced to any degree and be made more responsive to the information the region needs. The following levels of

classification of different categories of land use/ land cover have been recognized and mapped:

(a) Level-I Classification: The level-I classes were found to be readily available from satellite imagery. The minimum mapping unit would vary depending upon the interpretation method used. Level-I information could be presented at a scale of 1:1 million with the minimum mapping unit on the map being 3mm*3mm which covers (900 ha) 9 Sq Km. on the ground. Technical considerations concerning accuracy of interpretation with either visual or automatic procedures can be given as reasons for using such a large mapping unit. The level-I classification has been successfully applied using both digital and visual methods for interpretation of satellite data.

(b) Level-II Classification: The level-II classification can be achieved if 1:250,000 scale satellite imagery is used with a minimum mapping unit on the map i.e., 3mm*3mm which cover 56.25 hectare on the ground. It is suggested that the classification may be used effectively by those persons who have local knowledge of the region which is being mapped. Satellite imagery of different cropping seasons of the year are required to be used on suitable scale to obtain level-II information. It should be noted that the individual skill of the scientists are very important in determining the level of details and accuracy achieved. The land use/ land cover classification system up to level-II categories is shown in table-1.

(c) Level-III Classification: It is suitable for mapping on 1:50,000 and larger scales. This can be modified to meet any specific objectives of the mapping. The Smallest mappable unit of size 3mm * 3mm under Level-III classification on 1:50,000 scale covers 2.25 hectare area on the ground.

Table-1

Land Use/ Land Cover Classification System

Level-I	Level-II
1. Built Up land	1.1 Built Up Land
2. Agricultural land	2.1 Crop Land
	(i) Kharif
	(ii) Rabi
	(iii) Kharif+ Rabi
	2.2 Fallow
	2.3 Plantation
3. Forest	3.1 Evergreen/ Semi evergreen
	3.2 Deciduous forest
	3.3 Degraded or Scrub Land
	3.4 Forest Blank
	3.5 Forest Plantation
	3.6 Mangrove
4. Wastelands	4.1 Salt Affected Land
	4.2 Waterlogged Land
	4.3 Marshy/ Swampy Land
	4.4 Gullied/ Ravinous Land

	4.5 Land With or Without Scrub
	4.6 Sandy Area (Coastal and Desertic)
	4.7 Barren Rocky/ Stony Waste/ Sheet Rock Area
5. Water Bodies	5.1 River/ Stream
	5.2 Lake/ Reservoir/ Tank/ Canal
6. Others	6.1 Shifting Cultivation
	6.2 Grass Land/ Grazing Land
	6.3 Snow Covered/ Glacial Area

2.8 Description of Major Land Use/ Land Cover Classes

2.8.1 Built Up Land

It is defined as an area of human habitation developed due to non agricultural use and that which has a cover of buildings, transport, communication, utilities in association with water, vegetation and vacant lands.

All man-made constructions covering the land surface are included under this category. These are human settlements comprising residential areas, transportation and communication lines, industrial and commercial complexes, utilities and services, etc. Collectively, cities, towns and habitations are included under this category. Their shape and high reflectivity differ entiate them from other classes. Enhancement techniques and band

combination help segregation of different parcels. Rabi seasons data provide better expression of the built up area and appear in greenish blue tint where as the interfering influence of extraneous features that are common in Kharif season data such as weedy vegetation, accumulated water in depression and low lying areas, are minimised.

2.8.1.1 Urban (Towns & Cities)

Land used for human settlement of population more than 5000 of which more than 80% of the people are involved in non agricultural activities with much of the land covered by building structures. It includes parks, institutions, play grounds and other open space within built-up areas.

2.8.1.2 Rural (Villages)

Land used for human settlement of size comparatively less than the urban settlement of which more than 80% of people are involved in agricultural activities. All the agricultural villages covering 5 ha. area and more are included in this category.

2.8.2 Agricultural Land

It is defined as the land primarily used for farming and for production of food. It includes land under crops (irrigated and un-irrigated), fallow, plantations etc. Croplands are sub classified as (i) Kharif, (ii) Rabi and (iii) Kharif and Rabi. Multi temporal data and iterative contextual interaction help in the discrimination of agriculture land from other categories that are dominated by vegetative community.

2.8.3 Forest

It is an area (within the notified forest boundary) bearing an association predominantly of trees and other vegetation types capable of producing timber and other

forest produce. Forest, where the vegetation density (crown cover) is 40% or above is called dense or closed forest. If it is between 10 to 40%, it is called scrub and/or open degraded forest. Forests exerts influence on climate and water regime and also provide shelter for wildlife and livestock.

In the present frame-work of land use / land cover classification system this category includes all areas that are notified as forests with crown area density of 40%. Under this category at level-II following classes are included: (i) evergreen/semi-evergreen forests, (ii) deciduous forests (iii) degraded forests (crown density of 10-40%) (iv) forest blank (devoid of trees or bushes) (v) forest plantations (vi) mangroves. Discrimination of forests from the agricultural lands is possible using multi date data.

2.8.4 Wastelands

Waste lands are described as, degraded lands which can be brought under vegetative cover, with reasonable effort, and which are currently under-utilized, and lands which are deteriorating due to lack of appropriate water and soil management or on account of natural causes. Waste lands can results from inherent/imposed disabilities, such as, locations, environment, chemical and physical properties of the soil or financial or management constrains (NWDB, 1987). Level-II classes identified under this category are (i) Salt affected lands, (ii) waterlogged land, (iii) Marshy/Swampy land, (iv) Gullied/Ravinous land, (v) land with without scrub, (vi) Sandy area, (vii) Barren rocky/Stony waste/Sheet rock area.

2.8.5 Water Bodies

The class comprises areas of surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as streams, rivers, canals etc. These are clearly seen on

satellite false colour imagery in blue colour.

2.8.6 Others

All other land use/land cover conditions not included in any of the classes described earlier and that are either area specific or with limited areal extent in the overall context of the total geographical area of the district are included under this category. This category is also open to include any such land use/land cover condition, not listed in this frame work but of the local significance in a given area. The level-II classification includes shifting cultivation, grassland/ grazing land and snow covered/ glacial areas.

2.9 Land Use mapping In India

Land use land cover surveys using remote sensing techniques have been primarily conducted in the country by the National Remote Sensing Agency, Hyderabad; Indian Institute of Remote Sensing, Dehradun; Space Application Centre, Ahmedabad; Centre of Studies in Resources Engineering, IIT, Bombay; Civil Engineering Department, Earth Sciences Department and School of Hydrology, University of Roorkee; All India Soil and Land Use Survey Organisation and Survey of India.

NRSA (National Remote Sensing Agency) has contributed significantly to the land use/ land cover mapping using remote sensing techniques. Land use map in the scale of 1:250,000 using Landsat Imagery have been prepared for various regions of Andhra Pradesh, West Coast, Nagaland, Mizoram, Orissa, Uttar Pradesh, Tripura and Arunachal Pradesh.

Baldev Sahai (1983) reviewed the state of at in India and suggested a three ties approach; ie. satellite, aerial, ground which provide the complete or optimum information.

This classification scheme is quite incompatible with remotely sensed data. It gives the land utilisation classes as follows:

(i) Forests

(ii) Area under non agricultural uses

(iii) Barren and uncultivable land

(iv) Permanent pastures and other grazing lands

(v) Miscellaneous trees crops and groves not included in the net area sown

(vi) Culturable waste

(vii) fallow land other than current fallows

(viii) Current fallow

(ix) Net area sown

Gautam N.C. and Narayan, E.R.A.(1983) have carried out study for land use and land cover inventory and mapping for Andhra Pradesh. The study evaluates how well data from the Landsat MSS could be used to detect, identify and delineate land use features within the Andhra Pradesh state.

Chinnamani S. and et al. (1983) investigated land use changes in relation to hydrology of Bhawani basin using remote sensing techniques. They have used Landsat MSS data in conjunction with the historic data acquired from the SOI topographical maps and field data. They used visual interpretation technique for land use change detection.

Sharma, K.P. and et al.(1984) prepared a land use and land cover map for Dehradun-Roorkee region using visual interpretation technique. Area of each land use/ land cover category was determined for the year 1972 (Dec.) and 1977 (April).

Porwal, M.C. and et al. (1988) prepared a forest composition cover type map using Landsat TM FCC on 1:250,000 scale. Landsat TM FCC have been visually interpreted for delineation of forest cover type identified on the basis of tone/ colour, texture, pattern and correlated with geographical location.

Singh, R.D. et al.(1988) carried out visual as well as digital analysis for a part of Landsat scene (Path and Row 157/039). The study covered 344.89 Sq Km. of Paonta Sahib area, a part of the Doon valley, representing different types of physiography, soils, landuse and varied crops as well as natural vegetation. On the basis of this study it was concluded that maximum likelihood classification was more accurate for mapping of various landuse/ land cover classes as compared to minimum distance and parallel piped classifier programmes.

Pathan, S.k. and et al.(1991) have carried out urban land use mapping of forest cover and land use classes of Ahmedabad city and its environs. In this study visual and digital both techniques were applied. Spatial distribution of various urban uses and the space devoted to each urban land use has been brought out.

Bhar, A.K. and et al.(1987) prepared a land use map of upper Yamuna catchment using remotely sensed data. Six land use categories of hydrologic importance deciphered from the imagery. In order to minimize the effect of sun shadow in digital processing, the MSS2/MSS4 band ratio image file found to be workable though could not eliminate the same completely.

Choubey, V.K. and et al.(1989) carried out study on land use of Sabarmati basin using multi band Landsat imagery. Seven land use categories were identified from the

imagery. Choubey, V.K.(1990) has also carried out hydrological land use mapping of Malprapha and Ghatprabha catchments of Krishna basin. Based on the study, the recommended landuse for both catchments taken into account the suitability of soils, its erosion status , the availability of ground water potential and the existing land use practices in the area.

3.0 STATEMENT OF THE PROBLEM

Land cover is an intrinsic part of the terrestrial ecosystem and, as such, it forms an important parameter in hydrological modelling. Various hydrologic processes such as infiltration, evapotranspiration, soil moisture status etc. are influenced by land use/ land cover characteristics of a watershed. However, conventionally it is difficult to get land use/ land cover information for mountainous watersheds due to inaccessibility and other terrain problems. The remote sensing has been proved to be a powerful tool for mapping of basic land use/ land cover types efficiently over larger areas.

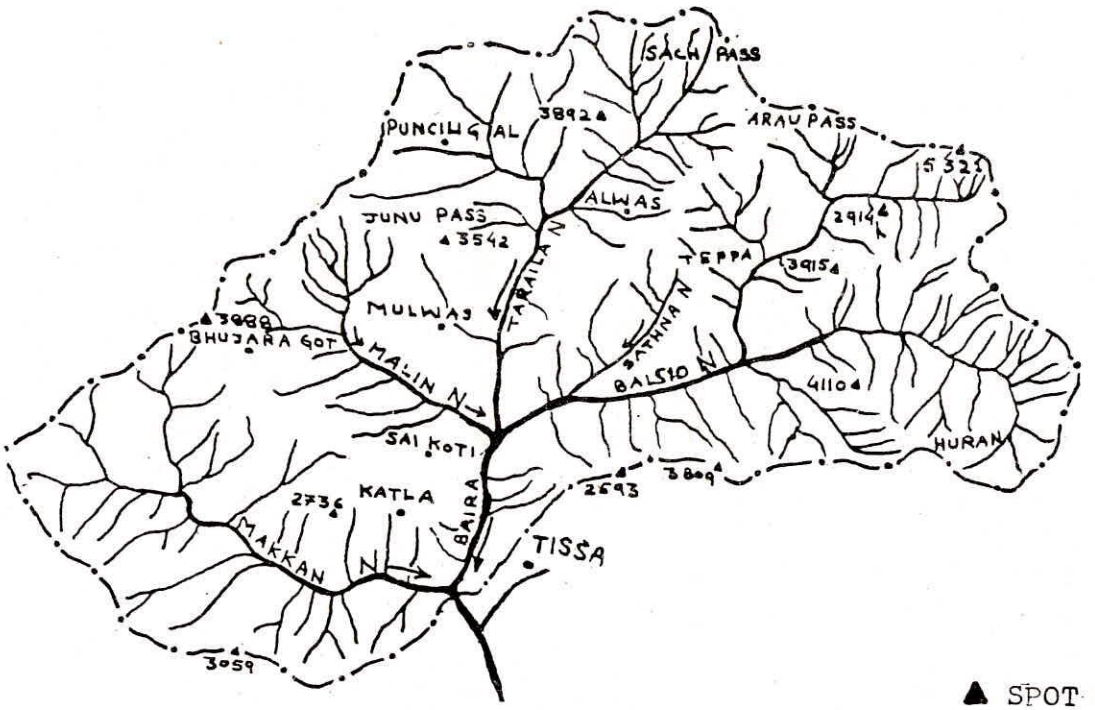
Western Himalayan Regional Centre (NIH), Jammu has taken up Representative Basin Studies for the Baira nalla sub catchment above Tissa (H.P.). Various hydrological and hydrometeorologcal studies have been initiated. In this connection land use/ land cover map of the representative basin was required for various hydrological studies. Therefore, land use/ land cover map of the area was prepared in the present study using remotely sensed data.

4.0 STUDY AREA

The present study was conducted for Baira nalla above Tissa, district Chamba (H.P.). It is a tributary of Ravi river (Fig.-1). The study area is surrounded between latitude 32° 47' to 33° 02' and longitude 75° 57' to 76° 23'. The catchment is on the southern slopes of pir panjal range in the western Himalayas.The area of the catchment is 585 Sq. Km with its elevation varying from 1600 m to 4400 m above mean sea level. The sub- catchment have steep slopes with "V" shaped valleys.

There are two types of soils dominate in the area. The upland soil is derived from quartzite parent material and is sandy with moderately high infiltration rates. At lower elevations old river terraces contain more clay and have a lower infiltration rates. Soil depths on the upper slopes are shallow and depth varies from 45-60 Cm approximately.

Geologically the Baira nalla sub catchment lies within lesser Himalayas. The lesser Himalayas are separated from Siwalik rocks by main boundary thrust.The main rock types occurring in the area are dollomite, limestone, philates, mica, schist, quartz(gray) etc.There is unconformity in depositions of different layers. Rocks are highly fractured and plains are developing probably due to instability. Because of the presence of dollomite, limestone etc. the area is very prone to erosion by process of chemical weathering when they come in contact with water. In philates (low gravity metamorphic rock) and quartzite in the barren slopes water percolates along the fractures and erosion is caused due to biological weathering.



(SCALE 1:250,000)

Fig 1. Drainage Map of Baira Nalla Sub Catchment above Tissa (H.P.)

The area is affected due to western disturbances during winter when precipitation is mainly in the form of snow. Rain occurs mostly during July to August. Annual rainfall of 1034 mm, 886 mm, 1433 mm and 1136 mm in 1980, 1985,1986 and 1987 respectively have been reported for the district Chamba. The annual flood at Baira at Tissa is of the order of 160 Cumecs. Temperature during winter is low and remains below zero from December to February.

5.0 MATERIALS AND METHODS

The present study was carried out using standard false colour composite paper prints of Indian Remote Sensing satellite (IRS 1B, LISS-II) for the period 13th October, 1993 on 1:250,000 scale. The entire sub catchment was covered in two scenes of IRS 1B, LISS-II imageries. The mosaic of the study area is given in Fig-2. The geometric resolution of IRS 1B/ LISS-II satellite is 36.25 m. The wavelength ranges of IRS-1B satellite are 0.45-0.52, 0.52-0.59, 0.62-0.68 and 0.77-0.86 micron meter respectively.The other details of the imageries are given in Table-2.

Table-2

Details of Satellite Imageries Used

Sl.No.	Satellite	Sensor	Date of Pass	Path/Row	Product Type
1.	IRS-1B	LISS-IIA2	13.10.1993	31/44	FCC (2,3,4)
2.	IRS-1B	LISS-IIB2	13.10.1993	31/44	FCC (2,3,4)

The study area is covered in three Survey of India toposheets. The identification number of these toposheets are 43P, 52C and 52D on 1:250,000 scale. The drainage map of the study area was prepared from the toposheets. The study area was identified on satellite imageries by superimposing the drainage map.

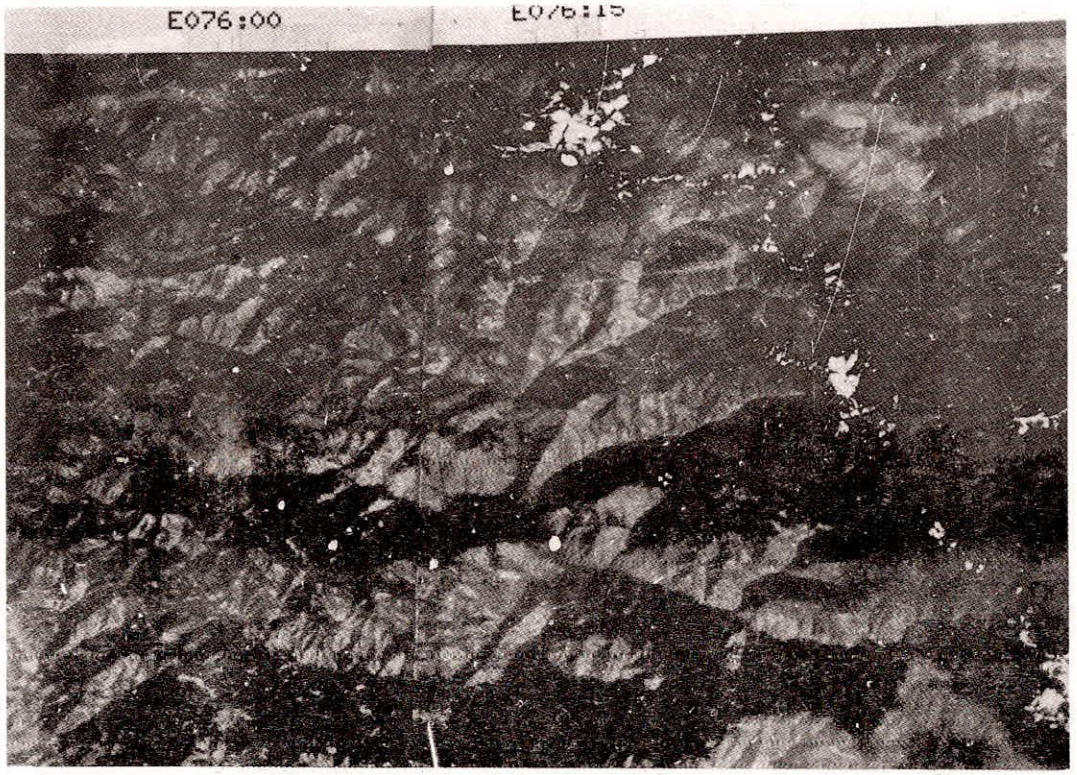


Fig 2. IRS-1B FCC viewing Baira Nalla Sub Catchment of 13 Oct. 1993 above Tissa (H.P.)

Various land use/ land cover feature in the Baira nalla sub catchment were delineated by visual interpretation of standard false colour composite paper prints (IRS-1B, LISS-II). The interpretation was based on shape, size, tone/colour, texture, pattern and locational aspects of the particular feature on the satellite imagery. The smallest mappable unit to depict various information on satellite imagery of scale 1:250,000 was 3*3 mm. The level-II classification was adopted to prepare land use/ land cover map in the present study.

The study area has been divided into five major land use/ land cover categories. These includes agriculture, forest, Barren rocky/ stony waste, degraded or scrub and snow covered areas. In this connection land use/ land cover interpretation key developed for standard false colour composite (FCC) generated with a combination of IRS bands 2, 3, and 4 on a scale of 1:250,000 was used. The main features of the interpretation key for the present land use/ land covers are:

(i) Agriculture/ Crop lands:

(a) Tone/ Colour- Bright red to red.

(b) Size- Varying in size.

(c) Shape - Regular to irregular.

(d) Texture- Medium to smooth.

(e) Pattern- Contiguous to non contiguous.

(f) Location- Plains, hill slopes, valleys, cultivable wastelands etc.

(g) Association- Amidst irrigated (canal, tank, well etc.)
and unirrigated(rainfed/ dry farming arable lands,
proximity to river/ streams etc.

(ii) Forest (Evergreen/ Semi evergreen) :

(a) Tone/ Colour- Bright red to dark red.

(b) Size- Varying in size.

(c) Shape- irregular, discontinuous.

(d) Texture- Smooth to medium depending upon crown density.

(e) Pattern- Contiguous to non contiguous.

(f) Location- High relief mountain/ hill tops and slopes and
within notified areas.

(g) Association- High relief/ slopes exposed to very heavy
rainfall zones.

These are closed (40% tree cover) or high density forest cover and coincide with the zones of high rainfall and relief.They provide shelter to wild life and livestock. They influence the climate and water regime and protect the environment.

(iii) Barren Rocky/ Stony Waste

(a) Tone/ Colour- Greenish blue to yellow to brownish.

(b) Size- varying in size.

(c) Shape- irregular and discontinuous.

(d) Texture- Very course to course and medium.

(e) Pattern- Linear to contiguous and dispersed.

(f) Location- Steep isolated hillocks, hill slopes/ crest,

plateau and eroded plains.

(g) Association- Barren and exposed rock/ stony wastes,

mined areas and quarried sites,boulders.

These are rock exposures of different rock types which occur as massive, boulders, stony waste etc. in hill forests, plateau, plains etc. These are barren and are devoid of soil cover and vegetation.

(iv) Degraded or Scrub Land:

(a) Tone/ Colour- Light red to dark brown.

(b) Size- Varying in size.

(c) Shape- Irregular, discontinuous.

(d) Texture- Course to mottled.

(e) Pattern- Contiguous to non contiguous.

(f) Location- Mountain slopes, isolated hills and foot

slopes and within notified forest areas.

(g) Association- Hill slopes having skeletal soil, different

forest types/ sub types and where abiotic interference.

It accounts for less than 20% of the tree cover and are also called as open forests. The degradation is due to biotic and abiotic disturbances caused to dense forest cover. It contributes to land degradation found on uplands and on foot slopes with this soil cover.

(v) Snow Covered/ Glacial Areas:

(a) Tone/ Colour- bright to white.

(b) Size- Large and extensive.

(c) Shape- Irregular, continuous.

(d) Texture- Smooth.

(e) Pattern- Contiguous.

(f) Location- Mountain peaks and slopes.

(g) Association- High relief and glaciers.

The interpretation was verified with the existing ancillary information like Survey of India topographical maps, forest cover map and photographs of the study area at selected points for the purpose of ground truth information. The photographic views of agricultural and forest lands in baira nalla sub catchment are given in Fig-3 & 4 respectively for ground truth information. The area under each land use category was measured using Planimeter.

(Photographs Of Baira Nalla Sub Catchment)

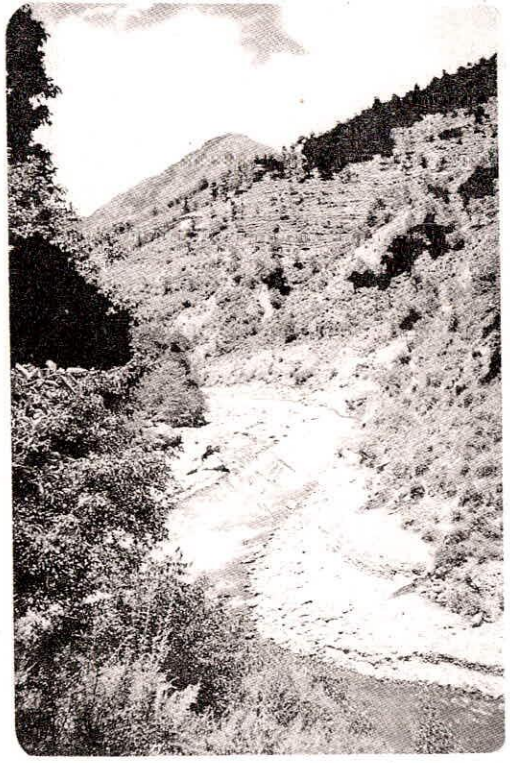


FIG 3. View of Agriculture Land.

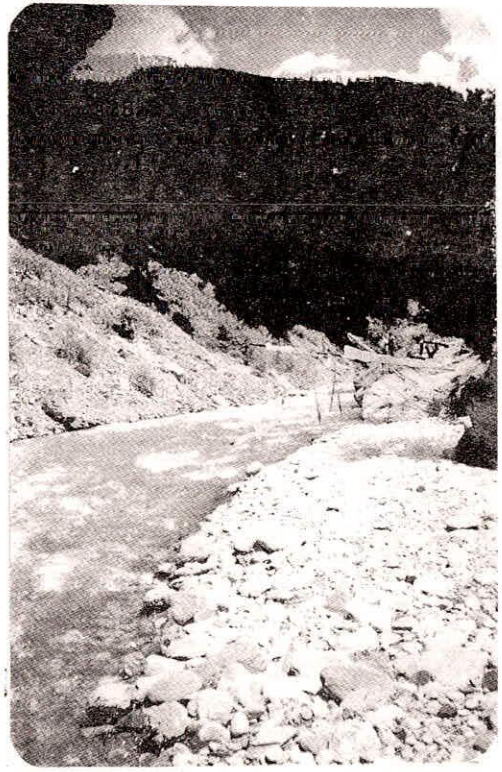


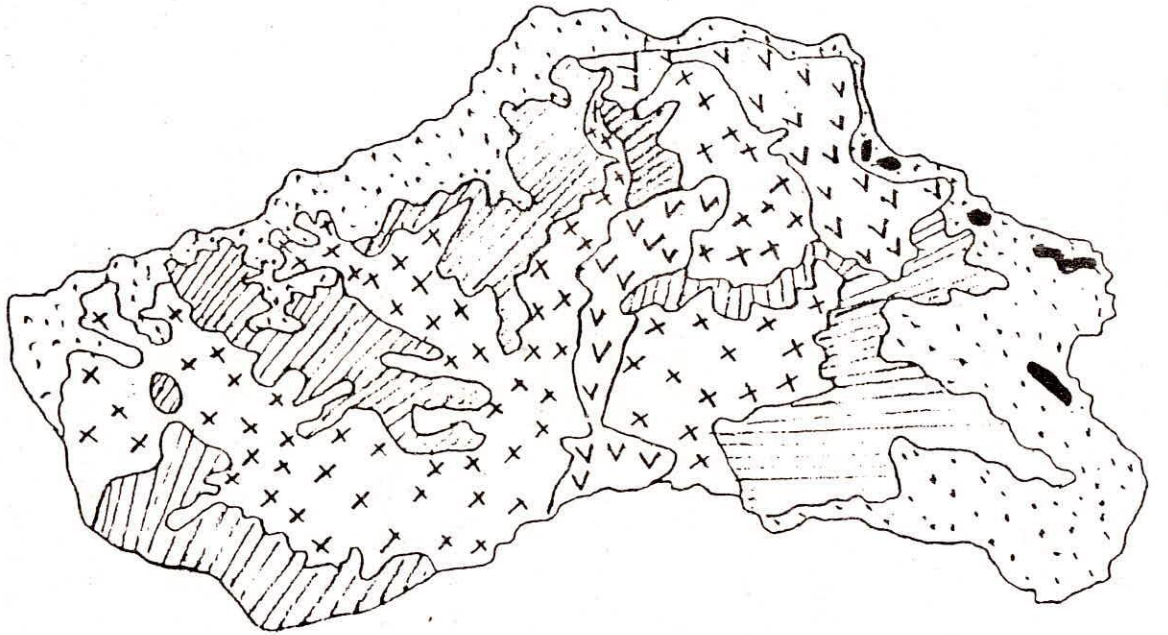
Fig 4. View of Forest Land.

6.0 RESULTS AND DISCUSSION

The present study was conducted using standard false colour composites (FCC) generated with a combination of IRS-1B (LISS-II) bands 2 (wavelength range 0.52-0.59 micron), 3 (0.62-0.68 micron) and 4 (0.77- 0.86 micron) on a scale of 1: 250,000 scale. The various categories of land use/ land cover were delineated using visual interpretation technique. The major ground truth information were obtained from Survey of India Topographical maps (43P, 52C and 52D) on 1:250,000 scale and some photographs taken during various field investigations under the representative basin studies.

The study area was classified under five land use/ land cover categories in the present study. These are agriculture land, forest, barren/ rocky land, degraded/ scrub land and perennial snow. The land use / land cover map of the area is given in Fig-5. The interpretation of various classes was based on some aspects such as tone/ colour, size, shape, texture, pattern, location and association of the particular feature on the satellite imageries. The built up areas could not be identified under the present study because the settlements in the area are sparse. Land use/ land cover distribution in the Baira nalla sub catchment are given in the Table-3.

The graphical representation of the results is given in Fig-6. It is evident that main land use in the Baira nalla sub catchment is agriculture. It accounts for 38.15 % of total sub catchment under the present study. It also includes the areas under fallow land. The forest land is 33.39 percent. The maximum forest area is under Deodar. However, biotic and abiotic disturbances are causing rapid land degradation in the area. The results have showed that there exist 10.77% degraded/ scrub land under the present study.



(Scale 1:250, 000)

Legend

- Barren/Rocky Land
- Permanent Snow
- Degraded or Scrub Land
- Forest
- Agriculture

Fig-5

Land use / Land Cover Map of Baira Nalla Subcatchment using FCC of IRS-1B (13 Oct. 1993)

(IRS-1B, LISS-II FCC Dated 13.10.1993)

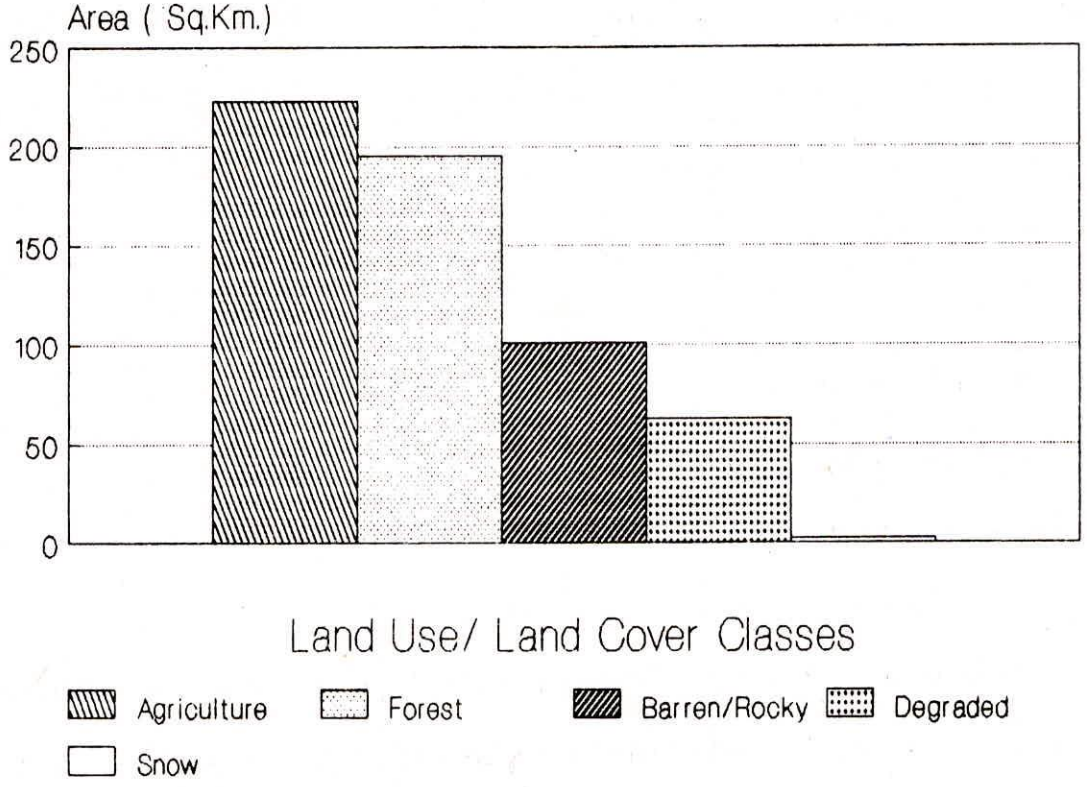


Fig-6 Land Use/ Land Cover Distribution in the Baira Nalla Sub Catchment Above Tissa (H.P.).

Table-3

Land Use/ Land Cover Distribution in the Baira Nalla

Sub Catchment Above Tissa (HP).

Sl.No.	Land use/ land cover category	Area (Sq. Km)	% Area of land use/ land cover in the sub catchment
1.	Agricultural Land	223.15	38.15
2.	Forest	195.34	33.39
3.	Barren/ Rocky land	100.82	17.23
4.	Degraded/ Scrub Land	63.00	10.77
5.	Permanent Snow	2.63	0.45

It is evident that upper most hill slopes along the boundary line of the sub catchment are barren/ rocky. The area under barren category is 17.23 percent under the present study. The rock exposures are dominant on these lands and therefore vegetation and soil cover is a limiting resource. The satellite imageries have showed that there exists some perennial snow cover during the period of present study. The perennial/ permanent snow accounts for 0.45 percent in the study area.

It is seen that mountain slopes are susceptible to land slips due to rains. The soil erosion is a major problem in the area. Therefore, management of soil and water resources

is primarily important in improving the socio-economic conditions of the people in this region. This task should be obtained through implemementing watershed management programmes for rational utilization of land and water resources for sustained productive and upliftment of the economic conditions of the people in this region.

7.0 CONCLUSIONS

In the present study land use/ land cover mapping for the Baira nalla sub catchment above Tissa (H.P.) was conducted using IRS-1B/ LISS-II satellite data. The study was conducted through visual interpretation of satellite imageries based on various aspects such as tone/ colour, shape, size, texture, pattern, location and association of the particular feature. The study revealed the immense potentiality of IRS data for land use/ land cover mapping studies.

Five land use/ land cover categories could be deciphered from the standard false colour composites in the present study. These are agricultural land, forest, barren/ rocky land, degraded/ scrub land/ open forest and permanent snow cover. The main land use is in the area is agriculture. The major portion of the forest land is under Deodar. Biotic and abiotic disturbances are causing severe land degradation in the area. Watershed management through detailed studies for rational utilization of land and water resources should be adopted for sustainable productive and upliftment of socio-economic conditions of the peoples in this region.

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