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LANDUSE/LANDCOVER MAPPING OF DEVAK CATCHMENT, JAMMU (J&K)

आपो हि ष्ठा मयोभुव

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PREFACE

The Western Himalayan Regional Centre is engaged in conducting studies and research in the area of hydrology. For this, remote sensing applications in hydrological studies are also undertaken. In present study, Devak Catchment of Ujh river basin has been chosen for preparation of landuse/land cover map for the years 1958,1979,1990 and 1998 using satellite data and SOI topographical maps. Image processing and Visual interpretation has been carried out for preparation of landuse / landcover maps.

Land use and land cover is the most important source characteristics of a catchment. Various aspects of hydrologic studies can be undertaken if information on landuse and landcover is available for a catchment. Various hydrologic processes such as interception, infiltration, soil moisture and ground water recharge are influenced by landuse/landcover characteristics of a catchment.

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ABSTRACT

The Devak Catchment considered for the present study extends from 32°-35′ to 32°-45′ north latitude and longitude 75°-00′ to 75°-10′ east. The Devak River, one of the tributaries of Ujh River, originates from Baral at an altitude of 850 m above mean sea level.

Landuse and landcover exerts considerable influence on the various hydrologic phenomenons such as interception, infiltration, evaporation and surface flow. Various aspects of hydrological problems (i.e Rainfall-Runoff modeling, Sedimentation studies, etc.) can be studied if information on landuse / landcover is available for a Catchment. In the present study, a landuse / landcover map of Devak Catchment for the years 1958,79,90 and 98 upto Gura slathian, Jammu has been prepared by Image processing and Visual interpretation technique from the analysis of the IRS-1A L2B2 (FCC) data for the year 1990, IRS-1C LISS-III (Digital data) for the year 1998 and SOI topographic maps for the year 1958 &1979.

In this analysis Leve-I classification was adapted and the various categories of landuse are Mixed forest mainly pine, agricultural with sparse habitation, open scrub & scattered trees and water bodies (river). Results revealed a large change in the area of different landuse categories during the period from 1958 to 1998.The open scrub and scattered tress covering an area of about 46.17% in 1958 reduced to 9.90% in 1998.while the area under mixed forest increased from 36.68% in 1958 to 65.84% in 1998. The agriculture with sparse habitation also increased from 7.09 % in 1958 to 13.92 % in 1998. The main river drainage covering an area of about 10 % of the total catchment.

1.0 INTRODUCTION

Land is the most important natural resources on which all activities are based. Land use unlike geology, is seasonally dynamic and indeed is more changing. The increase in 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 & Narayanan 1983). Knowledge about existing land use and landcover and its trend of change is essential for various reasons (Kundalia and Chennaiah, 1978). Landuse data is also needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels (Anderson 1971).

Changes in landuse can be due to urban expansion and the loss of agriculture land, changes in river regimes, the effects of shifting cultivation, the spread of erosion and desertification and so on. This, therefore, requires not only the identification of features but also the comparison of subsequent data in order to recognise when valid change has taken place.

The land use change has a direct bearing on the hydrologic cycle. Various hydrologic processes such as interception, infiltration, evapotranspiration, soil moisture, runoff and ground water recharge are influenced by landuse/landcover characterstics of the catchment.

In this study, land use/land cover maps for the years 1958,79,90 and 98 of Devak catchment up to Gura Slathian, J&K, has been prepared using IRS-1A, LISS-II, B-2, FCC data for the year 1990, IRS-1C, LISS-III, digital data for the year 1998 and SOI topographical data for the years 1959 and 1979.

1.1 Definition of land use/land cover

Land use refers to "man's activities and various uses which are carried on land"(Clawson & Stewart, 1965). Land cover refers to "natural vegetation, water bodies, rock/soil, artificial cover and other resulting due to land transformation". The term land use and land cover is closely related and interchangeable. The purpose for which land is being used, commonly associated with different types of cover such as forest, agriculture, built-up and waste land and water bodies. The term land use relates to the human activities associated with a specific piece of land. The term landcover relates to the type of feature present on the surface of the earth. Urban buildings, lakes, glacial ice etc. are all examples of landcover types. Landcover of any area may be evergreen forest, recreation, wild life sanctuary or various combinations of activities.

1.2 Remote sensing as related to land use/land cover

Landuse / landcover are dynamic features over space and time. Therefore, it is difficult to get real time information through conventional means. On the other hand, an optimum land use planning strategy needs timely, accurate and up to date information in 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. For the past twenty years remotely sensed satellite-borne multi-spectral imagery has been increasingly used for land use and land cover mapping (NRSA 1978, 1979). 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).

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

(a) Land use can not 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.

(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 phenomenon and it changes from one season to another. Therefore terrain appearance also varies from season to season.

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

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

(d) The land use/land cover categories can not 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.

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

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

1.4 Land use/land cover classification

Classification is the grouping of subjects into classes on the basis of their properties and relationship they have in common. Thus, each land use category should be homogeneous in nature. It depends upon the regions, which is being studied, and number of land use classes of units that are being analysed.

1.5 Characteristics of a land use/land cover classification system

It includes the following points:

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

(b) Classification should be based on what is observed on the land. Minimum meaningful groupings should be made.

(c) Fieldwork should be planned based on the smallest mappable unit, which varies according to scale.

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

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

1.6 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/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) Identification 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 generalised. 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 within a classification, an arbitrary decision must be made. One must decide on an imagery scale or on the scale of representation of data. Data based scales of 1:1 million, 1:250, 000 and 1:50, 000 will serve the present level viz. Level-I, level-II and level-III classification, respectively.

1.7 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 recognised 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 1:1million with the minimum mapping unit on the map being 3*3 mm which covers (900hac) on the ground. Technical considerations concerning accuracy of interpretation with either visual or digital analysis 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 imagery is used with a minimum mapping unit on the map i.e., 3*3 mm 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 season of the year is required to be used on suitable scale to obtain level-II information. It should be noted that the individual skill of the scientists is 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-I.

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

Table-1
Land use/land cover classification system

Sl No.	Level-I	Level-II
1.	Built up land	1.1 Built up land
2.	Agriculture land	2.1 Crop land (i) Kharif Land (ii) Rabi (iii) Kharif + Rabi 2.2 Fallow 2.3 Plantation
3.	Forest Land	3.1 Evergreen/Semi, evergreen (i) Deciduous forest (ii) Degraded or Scrub land (iii) Forest Blank (iv) Forest Plantation (v) Mangrove
4.	Wastelands	4.1 Salt affected land 4.2 Water logged land 4.3 Marshy/swampy land 4.4 Gullied/Ravenous 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

1.8 Description of Major land use/land cover classes

1.8.1 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 relativity differentiate them from other classes. Enhancement techniques and band combination help segregation of different parcels. Rabi season data provide better expression of the built up area and appear in greenish blue tint whereas 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.

1.8.2 Urban (Towns & Cities)

Land used for human settlement of population more than 5,000 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, playgrounds and other open space within built up areas.

1.8.3 Rural (villages)

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

1.8.4 Agricultural land

It is defined as the land primarily used for farming and for production of food. It includes land under crops (irrigated and unirrigated), fallow, plantations etc. Croplands are sub classified as (I) Kharif, (II) Rabi, (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.

1.8.5 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 land/or open degraded forest. Forests exert influence on climate and water regime and also provide shelter for wild life and live stock.

In the present framework 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 forest from the agricultural lands is possible using multi date data.

1.8.6 Wasteland

Waste lands are described as, degraded lands which can be brought under vegetative cover, with reasonable effort, and which are currently under-utilised, and lands which are deteriorating due to lack of appropriate water and soil management or on account of natural causes. Wastelands can results from inherent/imposed disabilities, such as locations, environment, chemical and physical properties of the soil or financial and management constrains. Level-II classes identified under this category are (I) salt affected lands, (II) waterlogged lands, (III) marshy/swampy land, (IV) gullied/ravenous lands, (V) land with or without scrub, (VI) sandy area, (VII) barren rocky/stony waste/sheet rock area.

1.8.7 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.

1.8.8 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 Arial 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 framework but of the total significance in a given area. The level-II classification includes shifting cultivation, grasslands/grazing land and snow covered/ glacial areas.

2.0 LITERATURE REVIEW

The resources potentialities have been studied and recorded through conventional as well as remote sensing techniques by the specialist of various disciplines such as ecologists, geographers, hydrologists, town planners, etc. Extensive study of the country's natural belt and collection of enormous qualitative and quantitative information of various resources, using remote sensing technique have been done by National Remote Sensing Agency (NRSA) Hyderabad, Space Application Centre, Ahmedabad (SAC) and Indian Space Research Organisation, Bangalore.

2.1 Land use mapping in India and abroad

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 Science Department and School of Hydrology, University of Roorkee; All India Soil and land use survey organisation, Survey of India, State Remote Sensing Centres and National Institute of Hydrology.

The subject of agricultural resources has drawn the attention of geographers after the Second World War. Numerous parametric methods have been evolved to asses soil suitability (Storie,1978), Riquier and Bramao (1970). Brinkman and Smyth (1973) described basic principles of land evaluation for rural purposes. Anderson et al (1976) in their study presented the temporal dimensions of land use changes. Landsat data were also used in the delineation and mapping of soil salinity in India by Venktaratnam (1980). A good number of papers have been published by preparatory committee of National Natural Resources Management Systems (NNRMS), e.g. Ayangar et al (1980) on remote sensing for map Information, Karale et al (1978) on soil association mapping, Saxena et al (1982) on land resources inventory and land use planning. A Resource Guide Map Volume has been compiled by the Department of Geography, Madras University for the State of Tamilnadu.

Howard (1976), Harding and Scot (1978), Aldrich and Hellex (1980) found that visual interpretation of colour composites of landsat imagery yielded valuable information. Madhwan Unni and Roy (1979) found landsat imagery useful for monitoring forest cover. Similar studies conducted in Nagaland by Madhawan Unni (1980) produced maps showing subtropical, tropical evergreen, tropical moist deciduous forest and bamboo.

Water resources have been studied by hydrologists and have attracted the attention of Indian geographers and scientists who have also studied the problems of flood and river projects.

Singh (1976) has described the application of remote sensing for finding ground water potential zones in Rajasthan. Sahai et al (1980) made observation of space born satellite data for water resources management in Panchmahal district of Gujarat.

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 imageries have been prepared for various regions of Andhara Pradesh, West coast, Nagaland, Mizoram, Orissa, Uttar Pradesh, Tripura and Arunachal Pradesh.

Sahai et al. (1983) reviewed and suggested a three-tier approach; i.e. 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 tree crops and groves not included in the net area sown

(vi) Culturable waste

(vii) Fallow and other than current fallows

(viii) Current fallow

(ix) Net area sown

Gautam and Narayanan (1983) have carried out study for land use and land cover inventory and mapping of Andhra Pradesh. The study evaluates how well data from the landsat MSS could be used to detect, identify and delineate land use features with in the Andhra Pradesh state. Sharma et al. (1984) prepared a land use and land cover mapping for Dehradun – Roorkee region using visual interpretation technique. Area of each land use/land cover category was determined for the year 1972 (December) and 1977 (April). Porwal and Pant (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 locations.

Singh et al. (1988) carried out visual as well as digital analysis for a part of landsat scene (Path and Row 157/39). The study covered 344.89 km^2 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 land use/land cover classes as compared to minimum distance and parallel piped classifier programmes. Bhar and Bhatia (1987) prepared a land use map of upper Yamuna catchment using remotely sensed data. Six land use categories of hydrologic importance were deciphered from the imagery. In order to minimise 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 and Jain (1989) carried out study on land use of Sabarmati basin using multi band landsat imagery. Seven land use categories were identified from the imagery. Pathan 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, both visual and digital techniques were applied. Spatial distribution of various urban uses and the space devoted to each urban land use has been brought out. Jain (1992) has prepared land use map for Tawi catchment by using digital satellite data. Seven land use categories were identified in the catchment. Omkar (1993) has done snow cover mapping of Baira-sub catchment (HP), with visual interpretation. Omkar and Kumar (1995) have prepared landuse / landcover map for Baira nala sub-catchment (HP), using standard false colour composite image print. H P Samant and V Subramanyan (1998) have been prepared landuse / landcover changes in Mumbai-Navi Mumbai cities

3.0 STATEMENT OF THE PROBLEM

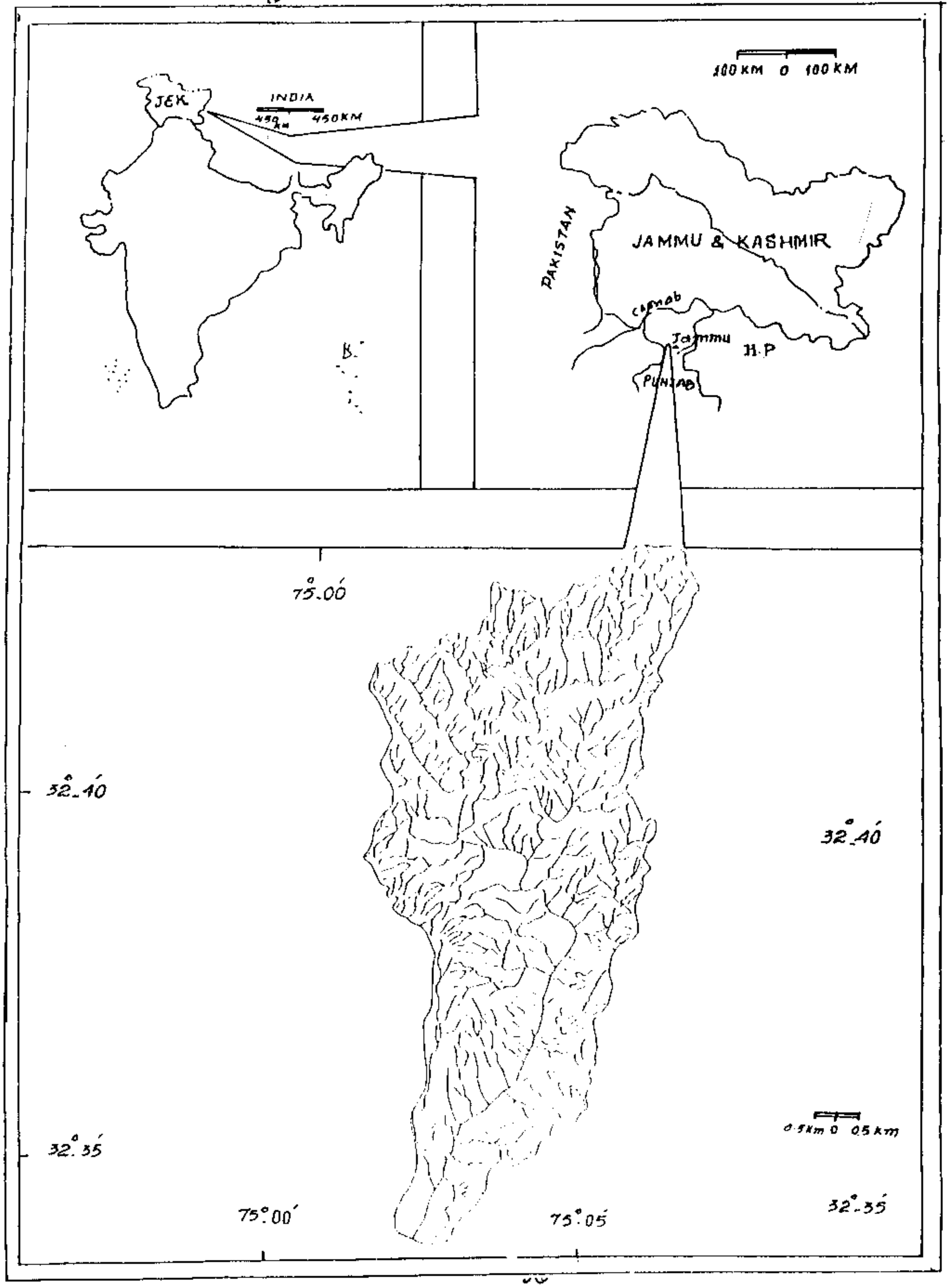
Land cover is an intrinsic part of the terrestrial ecosystem and, as such, it forms an important parameter in hydrological modeling. Various hydrologic processes such as infiltration, evapotranspiration, soil moisture status etc. are influenced by land use/land cover characteristics of a watershed. However,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

WHRC Jammu has taken up the study for the purpose to get the information of its landuse changes from 1958 to1998.

4.0 STUDY AREA

The present study is conducted for Devak catchment in district Jammu (J&K). Devak is an ephemeral stream and is a tributary of Ujh river. The study area is surrounded between latitude 32°-35′ to 32°-45′ North and longitude 75°-00′ to 75°-10′ East (Fig. 1). The catchment is on the southern slope of lesser Himalayan range in the western Himalayas. The area of the catchment is 95 km^2, with its elevation varying from around 340 m at the outlet to 850 m at the peak. The catchment has mild slope with approximate fan shape basin. From the farthest point, the river travels for a length of nearly 24 km to the outlet, near Gurha Slathian. The major tributaries of the Devak are Sangar Wali Khad, Plai wali khad and Karanal Wali Khad. No meteorological station has been setup in the catchment for measurement of rainfall and temperature, and the nearest meteorological station is at Jammu. The average temperature at Jammu varies from 4 to 40 deg celcius. The temperature at higher altitudes in the northern part is expected to be a little low. There are two rainy seasons-one from December to March, associated with the passage of western disturbances, and the other from mid-June to mid-September, due to southwest monsoon currents. Rain occurs mostly during July to August. The rainfall in October and November is generally small in amount. These disturbances occasionally give very stormy weather. In April and May thunder storms are occasionally observed giving light to moderate showers of rain. The southwest monsoon is a predominant feature in this region. The normal annual rainfall at Jammu station is 1055mm.

Fig. 1 Location map of Devak catchment Jammu(J&K)



5.0 METHODOLOGY

In the present study Image processing and visual interpretation technique are employed to carried out Landuse/Landcover classification using digital data and standard False Colour Composite (FCC) paper print of Indian Remote Sensing satellite.

5.1 Data used

a) Cloud free digital data of IRS – 1C, LISS-III of path 93 and Row48 acquired on 13th October 98.
b) Geocoded standars False Colour Composite (FCC) paper print of IRS-1A, LISS-2B2 of path 32 and Row 44 acquired on 21st February 1990.
c) Survey of India toposheet No. 43P/2 on 1:50000 scale (Surveyed on 1957-58).
d) Survey of India toposheet No. 43P/2 on 1:50000 scale (Surveyed on 1977-79).

5.2 Visual Interpretation

Standard False Colour Composite (FCC) paper print of Indian Remote Sensing satellite (IRS-1A, LISS-2 B2) for satellite pass on 21 Feb 1990 on path 32 and row 44 was used in this analysis. The interpretation is based on shape, size, tone/colour, texture, and pattern, and location aspects of the particular feature on the satellite imagery. The imagery is geocoded at 1:50 000 scale. The entire catchment was covered in one scene. The geometric resolution of IRS 1A, LISS-II camera is 36.25 m. The wavelength ranges of IRS-1A satellite are 0.45-0.52, 0.52-0.59, 0.62-0.68 and 0.77-0.86 μm for band 1,2,3 and 4 respectively.

The study area is covered in the Survey of India toposheet No. 43 P/2 on 1:50 000 scale. The base map consisting mainly of drainage map of the study area is prepared from the toposheet. This base map is registered with Satellite data after matching the drainage network in base map & Satellite data. The level-II classification is adopted to prepare land use/land cover map in the present study. The study area has been divided into four major land use/land cover categories.

These include agriculture with sparse habitation, forest, open scrubland and water bodies. For this purpose, land use/land cover interpretation key developed for standard FCC generated with a combination of IRS bands 2, 3, 4 on a scale of 1:50,000 is used. The main features of the interpretation key for the present land use/land covers are:

(I) Agriculture/crop land

(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 lands, proximity to river/stream 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 with in notified areas

(g) Association – high relief/slopes exposed to very high rainfall zones

These are closed (40% tree covers) 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) Open scrubland

(a) Tone / colour – light cyan 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 hill and foot slopes and with in notified forest areas

(g) Association – hill slopes having skeletal soil, different forest types/sub types

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

Using the above interpretation keys a thematic layer of landuse / landcover for the year 1990 was prepared. Using ILWIS GIS this map was digitized and polyganized to get the area of each class.

Landuse/landcover for the year 1958 and 1979 were also prepared using SOI toposheets No. 43P/2 on 1:50000 scale, surveyed in 1957-58 and 1977-79 respectively. This two thematic layers were digitized and polyganized using ILWIS GIS to get the area of each classes.

5.3 Digital Analysis

Digital analysis was carried out using Integrated Land and Water Information System (ILWIS), an image processing and GIS software. Multispetral cloud free digital data of IRS – 1C, LISS-III of path 93 and Row48 acquired on 13th October 98. was imported into ILWIS 2.1. Contrast and Spatial enhancement techniques were applied on raw data in ordered to make the raw image more interpretable. A standard FCC (RGB:432 band combination) was prepared and this image was registered with the help of SOI toposheet No.43P/2. Registration was done with high accuracy (sigma=0.159 pixels). The registered image was resampled with the pixel size of 10 m. The base map consisting mainly of drainage map of the study area is prepared from the toposheet and was digitized. The resampled image was masked with this base map. Based on the ground truth observation a training sets were identified on masked image for different landuse/ladcover. Finally the masked image was classified using the Box classifier having multiplication factor 5 to get a thematic map of landuse/lanecover for the year 1998. Histogram for this map was calculated to know the area of each class.

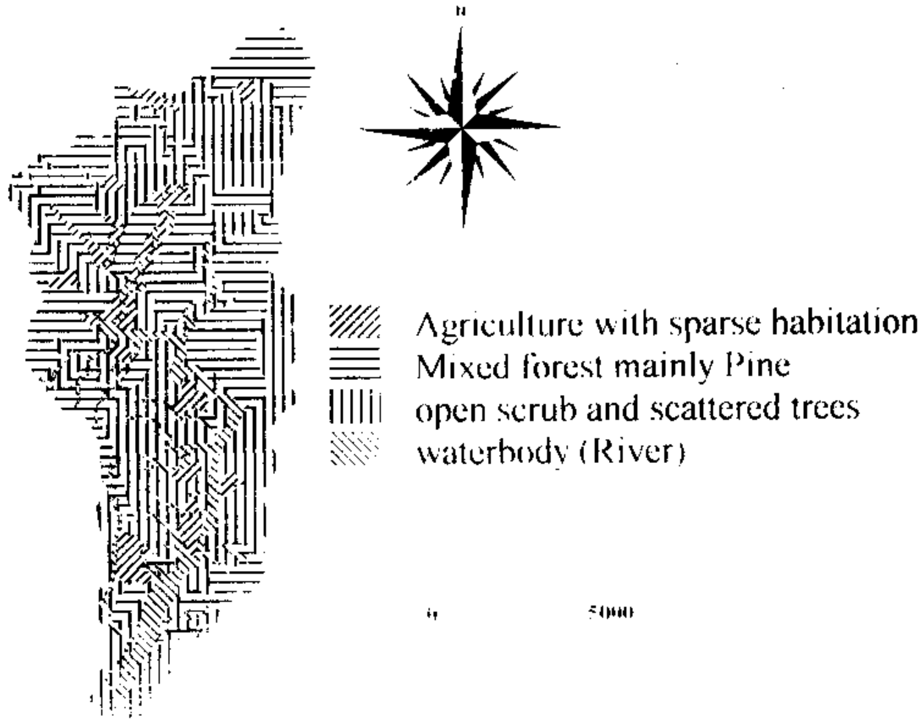
6.0 ANALYSIS AND RESULTS

The various categories of land use/land cover are delineated for different years using ILWIS image processing and visual interpretation technique. The base map is prepared from Survey of India topographical map (43P/2) on the 1:50,000 scale. The study area is classified under four land use/land cover categories in the present study. These are agriculture with sparse habitation, mixed forest mainly pine, open scrub with scattered trees land and water bodies (river). The land use/land cover maps for the years 1958, 79,90 and 98 are shown in Fig 2 to 5 respectively. The built up area could not be identified under the present study because the settlement in the area is sparse & small. Land use/land cover distribution in the Devak catchment for different years are given in Table 3. The graphical representations of the results are given in Fig 6. Results are shown that 46.17 % of the catchment was covered with open scrub and scattered trees in the year 1958, reduced to 9.90% in 1998. while the area under mixed forest increased from 36.68% in 1958 to 65.84% in 1998. The agriculture with sparse habitation also increased from 7.09 % in 1958 to 13.92 % in 1998. The main river drainage covers an area of about 10 % of the total catchment. It is evident that major part of the scrubland was replaced with the forest and agriculture.

Table: 1

Class	Area (Sq.Km)				Change in Area(Sq.Km)		
	1958	1979	1990	1998	1958-79	1979-90	1990-98
Agriculture with sparsed habitation	6.896 (7.09)	10.272 (10.56)	11.234 (11.55)	13.539 (13.92)	3.376 (48.96)	0.962 (9.37)	2.304 (20.51)
Mixed forest mainly pine	35.677 (36.68)	36.320 (37.34)	48.719 (50.09)	64.044 (65.84)	0.643 (1.80)	12.400 (34.14)	15.325 (31.45)
Open scrub and scattered trees	44.913 (46.17)	40.897 (42.05)	27.540 (28.31)	9.632 (9.90)	-4.015 (-8.94)	-13.357 (-32.65)	-17.908 (-65.02)
Waterbody (River)	9.782 (10.06)	9.782 (10.06)	9.776 # (10.05)	10.056* (10.34)	0.000 (0.00)	-0.005 (-0.05)	0.279 (2.86)

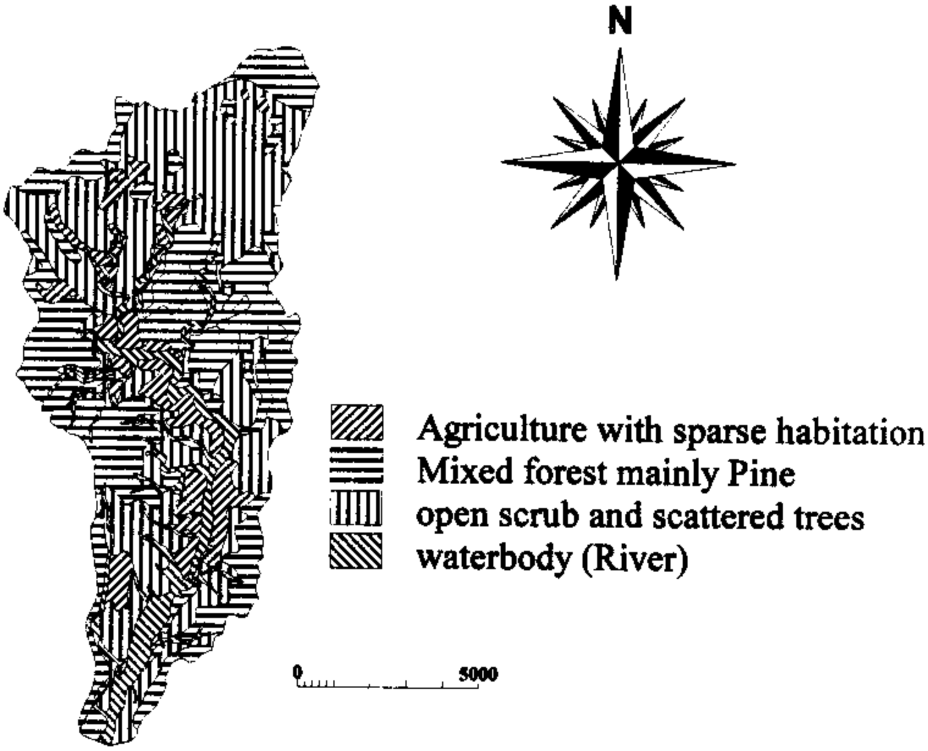
Note: values in brackets are in percentage. # : Pre monsoon * : Post monsoon



Landuse map of Devak Catchment for the Year 1958

Source: SOI sheet No.43 P/2
(surveyed 1957-58)

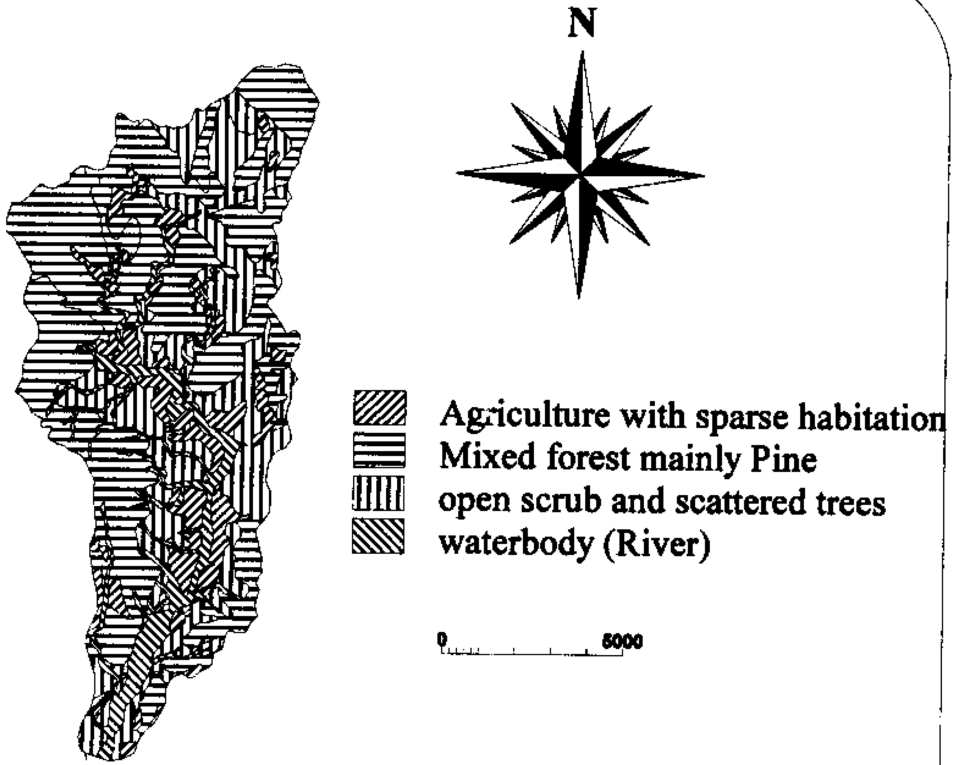
Fig. 2



Landuse map of Devak Catchment for the Year 1979

Source: SOI sheet No.43 P/2
(surveyed 1977-79

Fig. 3



Landuse map of Devak Catchment for the Year 1990

Source: IRS -1A L2B2, P32-R44
Acuired : 21-Feb-1990

Fig. 4

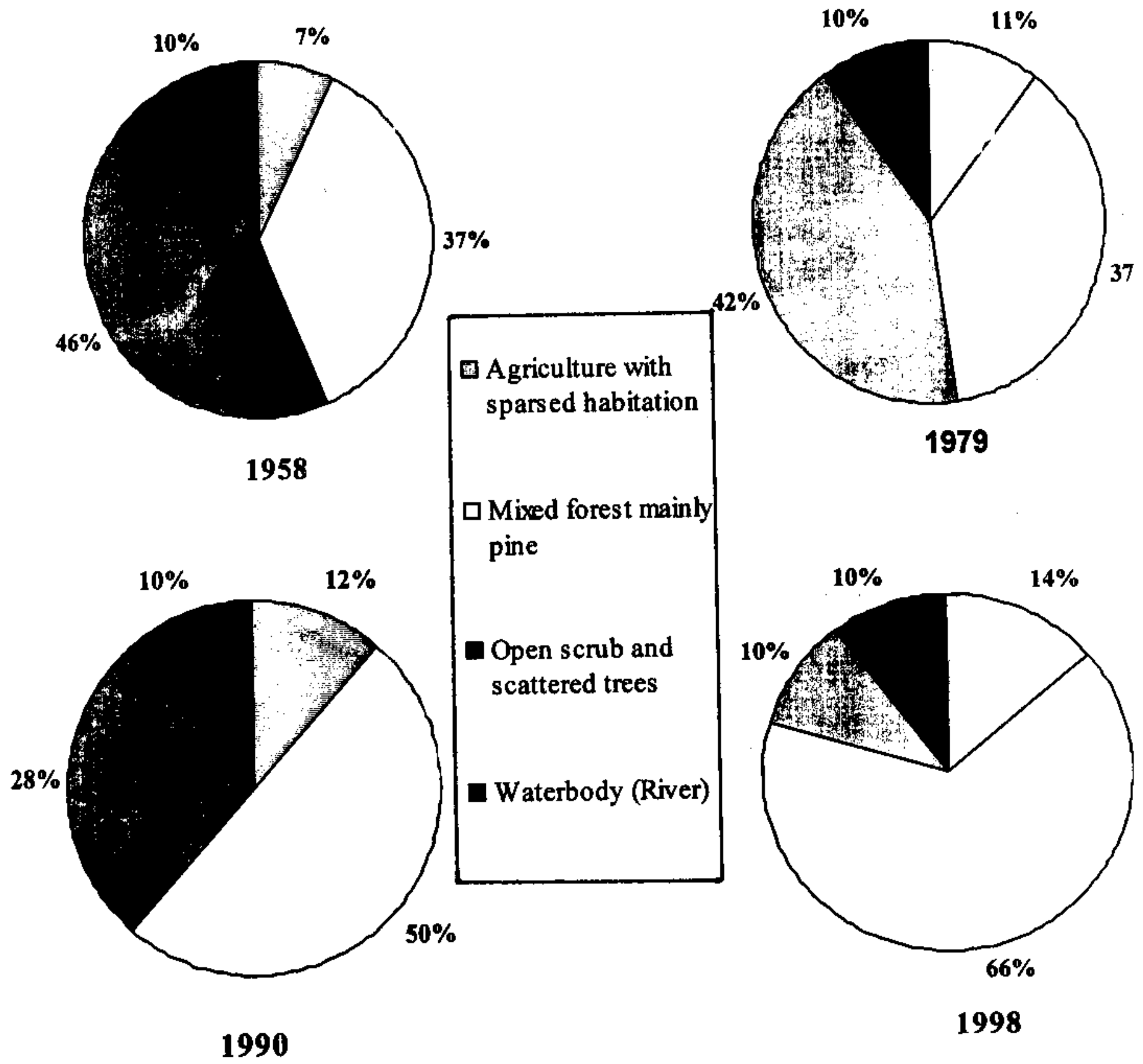


Fig:6

Graphical Representation of Lanuse/Landcover of Devak Catchment for Different Years

7.0 CONCLUSION

Land use/land cover mapping of Devak catchment shows that the forestland and open scrub land are the prominent feature of the area, together occupies 82.82 % of the total area till 1979. During the period from 1979 to 98, 76.4% area of the openscrub land has been replaced with forest and agriculture. The agriculture with sparse habitation covering an area of about 7.09 % in 1958 has been increased to 13.92 % in 1998. . The main river drainage covers an area of about 10 % of the total catchment. The upper reaches of the catchment, along the watershed line, are covered with forest-mainly pine. Because of sparse habitation in the catchment, agricultural area has not developed much. The agricultural activities are more along the water course of the river and its tributaries.

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