Impact of industrial shut down and land use change in Chaliyar Basin, India

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Abstract

This paper explains the impact of industrial shut down and land use change in Chaliyar river basin in Kerala, the southern state of India. The gradual migration of local labour for jobs abroad has made a remarkable impact on the land use in the local region. The large scale migration was chiefly the outcome of unemployment in the local region as a result of the shutdown of the rayon industry which was the only source of income to the local village community. Two parallel phenomena were observed since 2001: the migration pattern of labour force in the study area, and the changes in land use pattern. Given this background of the problem it is interesting to observe the land use changes through remote sensing during different time periods.

Keywords: industrial shut down, labour migration, land use change, local community, remote sensing, unemployment

Introduction

The Gwalior Rayon's started production of pulp and fiber for textile in 1960 which caused a rapid change in the life style of native population followed by a tremendous regional development. The Chaliyar River which flows near the factory was severely polluted by this industry. The Gwalior Rayon's besides, has created wide spread impact on agricultural productivity and health of the local residents . The overall influence was so critical that it aroused great opposition to the operation and continuation of this industry. With popular opposition both from the government and the people the industry ultimately closed in 2002. The primary and immediate impact of the shutdown was observed on outmigration of people in search of jobs and the secondary impact was realized on the land use change.

The pulp and fiber factory at Mavoor is the biggest private sector unit in Kerala. Mavoor is a village in Kozhikode district located 20km away from Calicut city in Kerala, India. Mavoor was like any other undeveloped village at the vicinity of lush evergreen forest of the Western Ghats, depending chiefly on plantation crops. The basic raw materials for pulp manufacture are bamboo and eucalyptus. The company acquired 30,000 acres of forest land to raise industrial plantation of eucalyptus. Every year 2,500-3000 acres of natural forests were turned into eucalyptus jungle. There was a ruthless exploitation of forests leading to a diminution in the supply of bamboo and eucalyptus and as a consequence shortage in the supply of raw material.

The industry consists of a rayon grade pulp division, a viscose staple fiber division and a paper plant. The pulp division employs over 4,000 workers and is the most significant in terms of employment. The fiber division employs 500 and the paper division employs around 1000 workers. Apart from nearly 6000 workers who are directly employed, about 10,000 people are indirectly dependent on the factory for their livelihood.

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After the opening of the rayon industry the land use structure of the region has underwent enormous change causing great impact on the natural vegetation, and agricultural lands. The industry was also a source of severe environmental hitch to the region's air, and water which lead to the ultimate shutdown. As a result of the shutdown of the rayon industry, all the local population was became unemployed. The local population by and large shifted out for better jobs in the Middle East countries. This study analyzes the impact caused from the shutdown of rayon industry on land use change. The application of remote sensing and image processing technologies are able to answer not only questions related to the spatial land use patterns but also precisely estimate the extent of land in various land uses and over time.

Nowadays industrialization, commercialization and migration have a major role in land use land cover change. The later is an important indicator of environmental change of a region these have been identified as high priority issues in global, national, and regional level. This paper assesses the impact of industrial shutdown on land use change.

Study area

The Mavoor rayon industry is located in the northern part of the Malapuram district and southern part of the Kozhikode district, the Chaliyar river act as a natural divide between the two districts. The study area is located 11^0 7'50" N - $11^0$17'50" N latitude and 75^0 45'0" E- 75^0 62'5" E longitude. The total geographical area of the study is 383247 sq Km. The Chaliyar river is draining the Mavoor region, which is flow from the western Ghats and debouching into the valleys and flowing to join the Arabian sea.

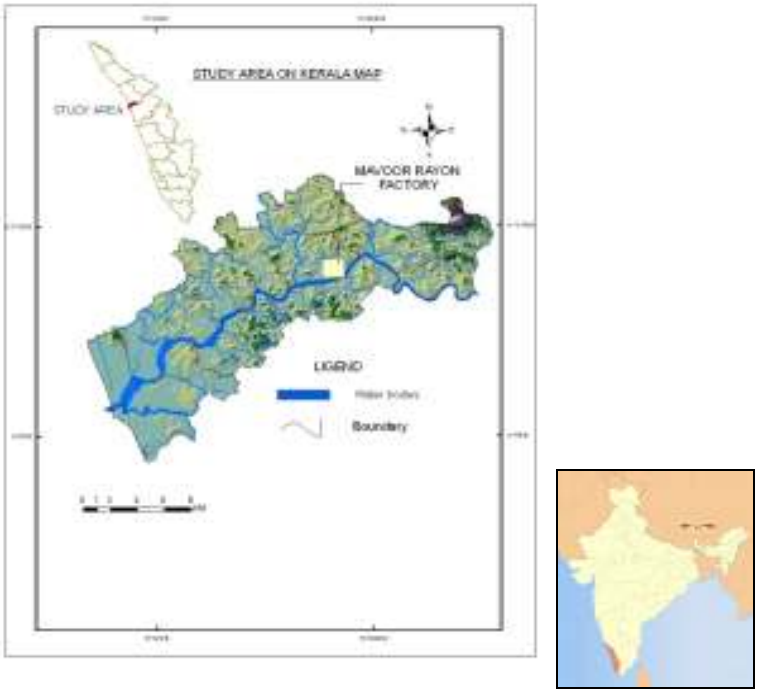

Figure 1. *Study areas on Kerala map*

Materials and methods

The base map of the study area was prepared using survey of India topographical sheets bearing Nos. 49M15, 49M16, 58A3 and 58A4 of 1:50,000 scales chiefly covering the Chaliyar river basin.

Population migration data was obtained from Economics and Statistics District office, Calicut and Mallapuram starting from 1971 – 2001.

The secondary data was collected for all the 14 Panchayats (group of villages) covered in the study area. Field survey was conducted to collect data related to migration, sources of income, type of crops grown, etc. and maps were prepared using ArcGIS.

The IRS 1C, and 1D satellite images were used to obtain Landuse data. The nature of land use change was monitored for a period of 10 years, ie., 5 years before the shutdown and 5 years after the shut down. And 1995 is taken as a base year followed by 2000, 2003, and 2005.

Satellite image data was prepared as follows:

Atmospheric correction:
All images were checked for atmospheric effects, and scene illumination. The simple haze correction was performed in order to remove the atmospheric disturbance in each image.

Image registration:
All images were geometrically rectified into the UTM coordinate system using ground control points (GCP's) that were visibly distinct. A least squares method was used to calculate the transformation from the toposheet to image. A first order linear transformation was used. The acceptable RMS error threshold value was <0.9 for all the multispectral images.

Land use/land covers type classification:
The images were geo referenced with the help of topographical map. Supervised classification was performed for six different classes. The number of classes was kept to a lesser number for the reason that the land use land cover has a monotony chiefly being dominated by water bodies, agriculture and plantation farms. For the purpose of checking the ground truth into different classes, a test of accuracy was measured in the way of kappa statistics.

A signature file was generated through unsupervised classification approach for 12 different land cover types these spectral clusters were further reduced to 6 clusters viz a vie Water bodies, Barren land, Built-up land, Mixed cultivation, Paddy cultivation, Rubber plantation, The accuracy and ground truth was assessed with the help of primary survey information and other supporting maps such as toposheet, and Google earth. All the images were subjected to accuracy assessment and the Kappa statistics resulted from the satellite images for the years, 1995, 2000, 2000, and 2005 was 91.00. 85.00. 80.95. and 87.00 respectively. Owing to the high resolution and assisted by good ground verification the results of accuracy assessment showed good results with <80%.

The results of accuracy assessment shows three categories of assessment results. First, the accuracy assessment shows that the error is accumulated between wet agricultural lands and grasslands. With an average Kappa index of 0.5.

Second, the dry agricultural lands, scrub and rural settlements have shown a high degree of overlap, with a kappa index of 0.9, for the reason being, all these features have very high reflectivity and brightness giving rise to discomfort in classification.

Third, the accuracy for other classes of land cover has shown very good distinguishable results. With a value of 0, the land covers included in this class of land use are water bodies, settlement / built-up area, dry barren lands, open scrub. All these with a kappa index ranging 0 to 0.2. Hence for our further analysis these land uses shall be taken in greater detail for further analysis.

Land use change in the Chaliyar river basin

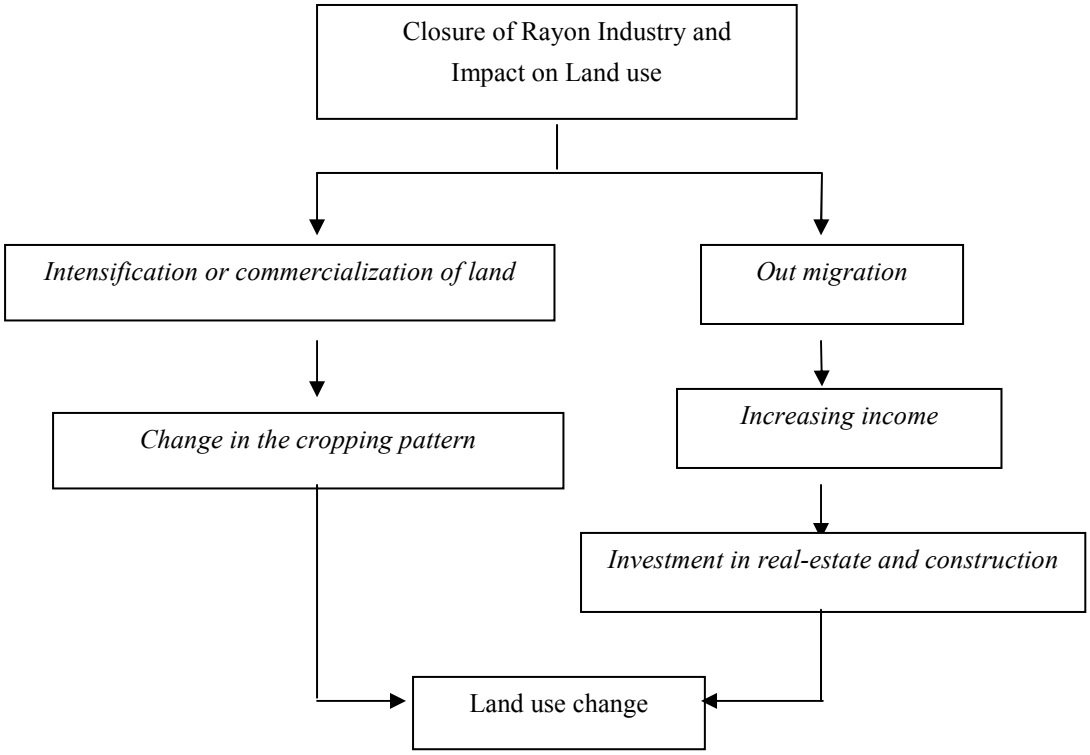

Figure 2. *Characteristic features of the land use change in Chaliyar river basin*

Land use change in 1995

The land use/land cover characteristics during 1995, reveals that the major land uses were the cultivation of paddy and mixed crops. 31.4% of the land area was used for paddy cultivation, 26.8% of land area was in mixed cultivation and 26.8% is not used for the agricultural purposes, only few areas are used in the rubber, cashew nut cultivation. In this period importance is given to the agriculture and allied activities.

Land use change in 2000

In the second period the land cover pattern has gradually changed in favor of paddy cultivation, however the total paddy cultivated area has reduced as compared to 1995. The total barren land has also considerably reduced. Compared to 1995 the total barren land is reduced -1.1 % in 2000, on the other hand the built-up land and rubber plantation has gradually increased. This means that the land utilization for food crops has reduced giving way to more remunerative cash crops.

Land use/land covers change in 2003

Compared to the earlier two periods (1995 and 2000), the prominent economic blockade in this period was the closure of the Mavoor rayon industry. Most of the local population was out of job and looking for new economic opportunities. In this period the construction has taken a lead and the built-up land is observed to suddenly increase. The increase is estimated to be about 13.6% than 1995. The paddy land has further reduced to 6.1% times than in 1995. The paddy grown in Kerala is not high quality therefore it is not a remunerative cash crop. The other aspect is that as a result of the jobless population in the region,

the construction and allied activity has unexpectedly taken prominence. The barren land has further reduced to 4% times than 1995.

Table 1. Land use classification IRS LISS III (1990-2005)

Land uses	Land Cover		Percentage of change	Land Cover		Percentage of change
	1995	2000		2000	2005	
Water bodies	21589	21589	0.00%	21589	21589	0.00%
Barren land	102691	98737	-3.85%	98737	76365	-22.66%
Built-up land	30860	56169	82.01%	56169	98187	74.81%
Mixed cultivation	102524	94287	-8.03%	94287	73438	-22.11%
Paddy cultivation	120257	102580	-14.70%	102580	85619	-16.53%
Rubber plantation	5336	9885	85.25%	9885	28049	183.75%
Classification accuracy	83.40%	86.90%		84.80%	87.20%	
Total land area	383247	383247		383247	383247	

Land use/land covers change in 2005

The dominant changes found since 2005 period is paddy, barren land, and mixed cultivation. 21.6% of the total land was used for the built-up purposes and only 22.3% is using in the field of paddy cultivation. On the other hand the mixed cultivation is also reducing giving way for construction and rubber plantation. The rubber plantation is growing faster in this period compared to any other period. More than 7.3 % of the entire land area is utilized on this purpose only.

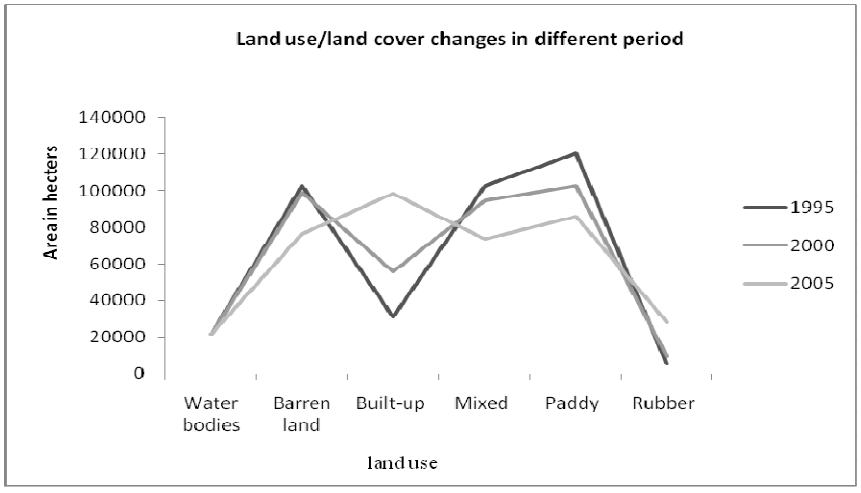

Figure 3. *Land use land cover change in Chaliyar river basin since 1995-2005*

Comparative study of land use land cover change in 1995-2005

Land use land cover changes in the Chaliyar river basin since 1995-2000, has been chiefly in agriculture, and other allied economic activities. Most of the land area under agriculture is changing into intensive cultivation of commercial crops, during 1990-95, 31.4% of the land area was utilized for paddy cultivation, but in 2005 it is observed that there is a sudden decline in the area covered for paddy. The total area under paddy is only 22.3% thereby a reduction of 9% of total land.

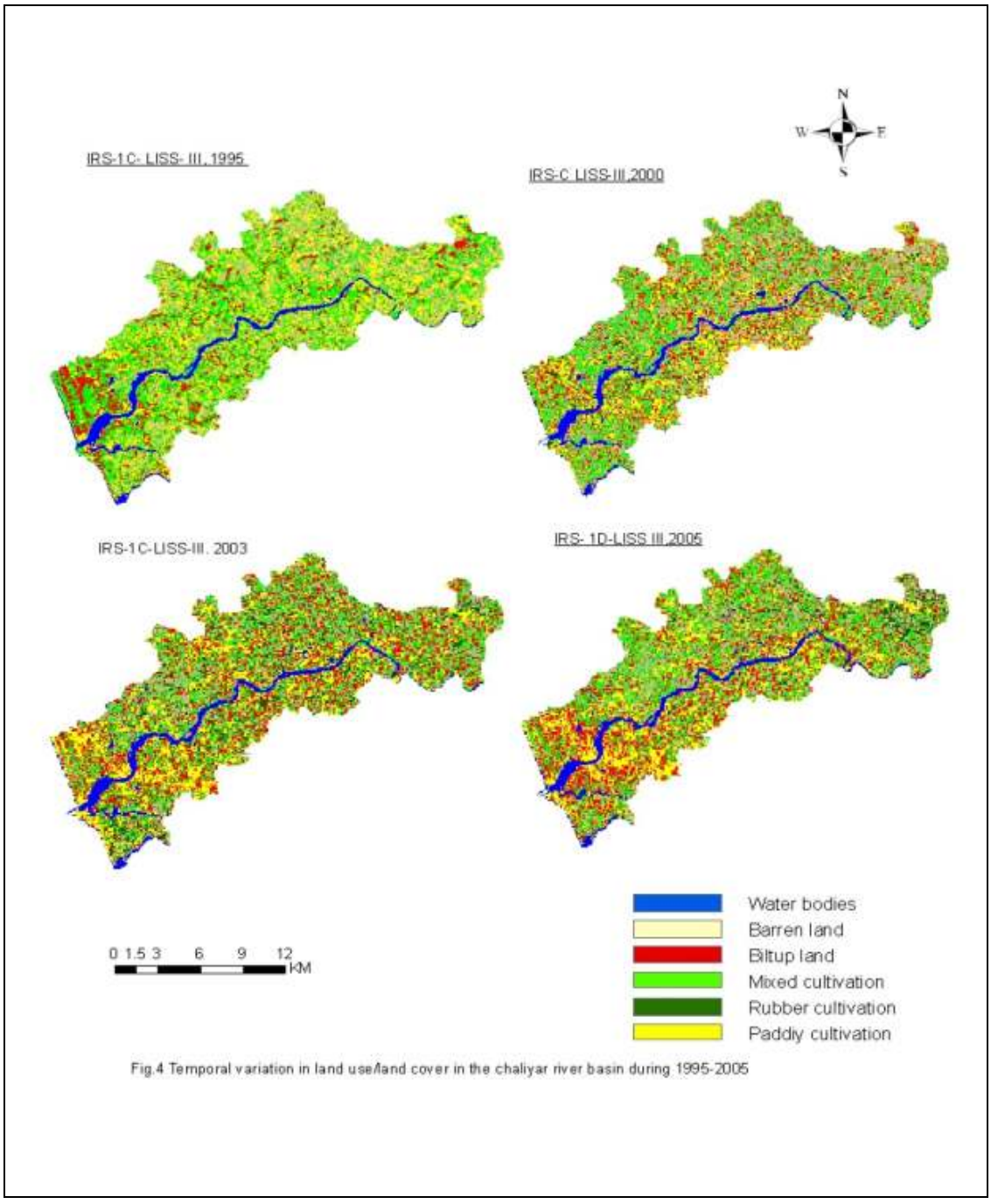

Fig.4 Temporal variation in land use/land cover in the chaliyar river basin during 1995-2005

Figure 4. *Temporal variations the land use land cover changes in the Chaliyar river basin*

On the other hand the rubber cultivation in 1990-95 is only 1.4% of the total land area but it has increased to 7.3% in 2004-2005. The mixed cultivation in 1990-95 periods was 26.8% and 2004-2005, it has reduced to 19.2% of the total land area during 2005. The mixed crops consist of areca nut, mango, coconut, and other fruits like banana, oranges etc. most of these crops in mixed crops are non remunerative compared to the commercial rubber cultivation. The total utilization for construction in 1900-95 periods was 8.5% which has increase to 25.7% in 2004-05. the barren land and marshy land also declined from 26.8% in 1990-95 to 20.1 in 2004-05. The sudden increase in construction has resulted due to increasing income especially from people employed in the gulf countries who have invested their savings chiefly in real estate and other economic and commercial activities.

Table 2. Classification accuracy

Class name	Producers accuracy	Reference total	User accuracy	Kappa statistics
a. 1995 image				
Water bodies	60.71	28	77.27	0.77
Barren land	83.33	72	88.24	0.87
Built-up land	61.22	66	81.08	0.80
Mixed cultivation	83.61	111	63.61	0.63
Plantation	33.33	6	66.67	0.66
Paddy cultivation	76.13	140	86.87	0.87
Overall Classification Accuracy				83.40%
b. 2000 image				
Water bodies	81.82	19	90.00	0.66
Barren land	83.17	60	52.38	0.46
Built-up land	94.78	39	68.34	0.68
Mixed cultivation	93.00	105	78.90	0.78
Plantation	100.0	4	80.00	0.80
Paddy cultivation	82.05	50	74.37	0.73
Overall Classification Accuracy				86.90%
c. 2003 image				
Water bodies	55.56	54	83.33	0.83
Barren land	67.14	70	81.03	0.80
Built-up land	75.49	102	79.38	0.77
Mixed cultivation	74.47	94	79.55	0.77
Plantation	61.90	42	83.87	0.83
Paddy cultivation	65.14	98	72.44	0.71
Overall Classification Accuracy				84.80%
d. 2005 image				
Water bodies	100.0	18	72.00	0.71
Barren land	70.37	81	81.43	0.80
Built-up land	75.90	83	71.59	0.69
Mixed cultivation	74.23	97	69.90	0.67
Plantation	86.67	15	92.86	0.93
Paddy cultivation	37.33	75	38.59	0.38
Overall Classification Accuracy				87.20%

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Table 3. Land cover using IRS LISS III

Land cover	1995	2005	% of change
Water bodies	21589	21589	0.00%
Barren land	102691	76365	-25.64%
Built-up land	30860	98187	218.17%
Mixed cultivation	102524	73438	-28.37%
Paddy cultivation	120257	85619	-28.80%
Rubber plantation	5336	28049	425.66%
Total land area	383247	383247	

Migration pattern of Chaliyar river basin

Out migration in Mavoor and Mavoor industrial region has acted as an important role in the Kozhikode district in Kerala. Malabar regions in Kerala has an ancient connection with Europe and Arabian countries, most of the people in this region is choosing for the industrial and trade purpose for Arabia and Arabian countries. After the closure of the Mavoor rayon industry majority of the unemployed laborers have secured jobs in gulf countries.

Table 4. Migration pattern in Chaliyar river basin during 1971 – 2001

Regions	Year			
	1971	1981	1991	2001
	(1 person in every 50 population)	(1 person in every 40 population)	(1 person in every 20 population)	(1 person in every 5 population)
Severely affected region	1579	2560	6228	31984
Moderately affected region	1473	2578	6724	32201
Partially affected region	2365	4218	10619	48764

Source: Economics and Statistics District office, Calicut and Mallapuram

Mmigration trend in 1971

After the starting of the rayon industry in 1961 the pollution and its influence is also starting, the peoples in this period are migrated only one person in every 50 population. In this period the peoples are mainly migrate in the nearest state like Karnataka or Maharashtra only, they are not choosing the gulf countries in that period due to the high transportation charges and high standard of living in abroad

Migration trend in 1981

During the first 1980 period their was a gradual trend in the peoples in Kerala moving to the gulf countries for the better job opportunities and better standard of living. In this period the peoples in the Mavoor industrial area also migrate in the gulf countries due to the continuous pollution and cancer death. During this period every one person in the 40 population are migrate in the gulf countries.

Migration trend in 1991

Due to the advanced industrialization and urbanization in the foreign countries during 1990 period's large number of peoples in the Mavoor industrial area is moving to the gulf countries. In this period one person in every 20 population is migrate in the west Asian and European countries. Due to the severe air and water pollution in the Mavoor industrial area large number of peoples migrate in to the nearest Panchayath in the surrounding regions

Migration trend in 2001

The tremendous change in the migration is focused in 2001 the period. In this period every one person in the 5 population is migrated in the outside. Due to the high level migration on this period is not only due to the better job and standard of ling but also the closure of the rayon industry creating the lot of unemployment in the Mavoor industrial area.

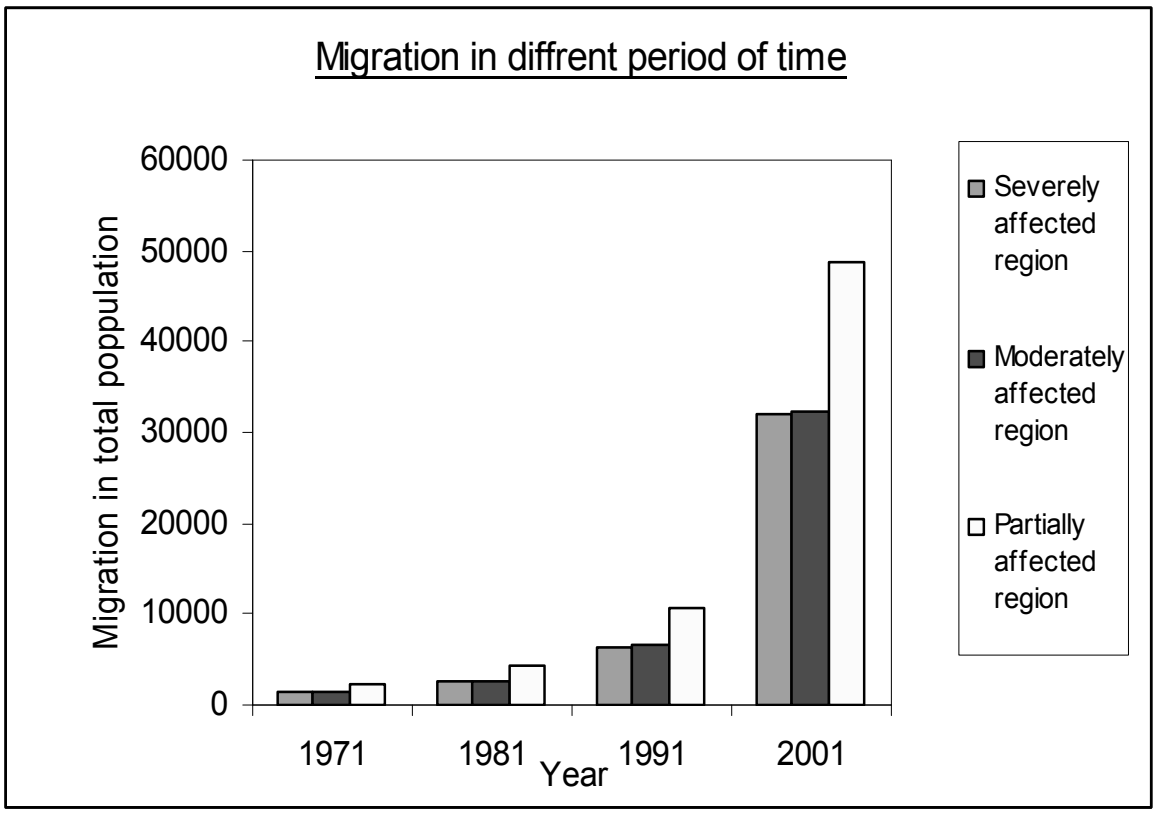

Figure 5. *Migration trend Chaliyar basin during 1971-2001*

Conclusion

The industrialization of any area brings with it its own set of advantages and problems. Environmental changes resulting from human activity like deforestation, land reclamation and emission of industrial waste have led to the environmental pollution. Pulp and paper mill pollution continues to harmful for the human beings and environment. Alternative methods and techniques are not used for the pulp and paper mills create a lot of problems on the environment, it is concluded that most of the land use has changed since 1995-2005. The continues change in the land use creating the miss management of the land and environment. The result brings out the quantum of damage already done to the forest cover, climate and the drainage network of the area. The environmental planners and developers should consider these aspects in future land development schemes.

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