UNDER UTILISATION OF AGRICULTURAL LAND IN RAJASTHAN: A DISTRICT LEVEL ANALYSIS

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CERTIFICATE

I, **Sanjeev Kumar Chahar**, certify that the dissertation entitled **"UNDER UTILISATION OF AGRICULTURAL LAND IN RAJASTHAN: A DISTRICT LEVEL ANALYSIS"** for the degree of **MASTER OF PHILOSOPHY** is my bonafide work and may be placed before the examiners for evaluation.

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DEDICATED TO

MY FAMILY

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CHAPTER-I

INTRODUCTION

1.1. Introduction

Land is the most valuable asset for the development of a country. Land resources are inherently linked with other resources like water, vegetation etc. Poor management of any related resource would affect the land quality. On the other hand agricultural practices directly affect the land quality. Land is an inextensible resource and its importance has been realized with growing human and animal population. The pressure on the land is increasing with time due to economic development activities. The agricultural land is facing competition from increasing demand of the secondary and tertiary sectors, which leads to conversion of productive agricultural lands into non-agricultural uses. The constraint on land is more in the rural areas on account of greater land based activities and demand for fuel, fodder and small timber. As a result large tracts of forests have been destroyed bringing about ecological and socio economic crisis. Given the pressure of agricultural land, we need to focus on degraded lands, which can be put under productive use with some additional efforts. Land degradation is a key issue in developing countries where declining land productivity is threatening the food production and environmental sustainability. The global nature of the problem has been recognized by the United Nations Environment Programme (UNEP). According to the Ministry of agriculture, 175 million hectares (mha) of the total 329 mha geographical area of our country suffers from one form of the degradation or the other, out of this 141 mha is subject to water and wind erosion and rest 34 mha is affected by special degradation problems like water logging, alkaline, acidic soils, salinity, ravines and gullies, shifting cultivation etc. These lands, which are subject to erosion, pose greatest threat to the country's economy. They also contribute to the loss of rainwater through excessive runoff around denuded slopes. It is generally accepted that there is not much scope to bring additional land under agriculture. Thus underutilized and degraded land offers us only option for extending the land under plough, which would promote and ensure food security to rural poor. The underutilized land has potential to provide employment to the rural population and can have positive externality impact on environment, if it is brought under crop cover in manner that is ecologically viable.

1.2. Concept of Wastelands and Definitions

'Land that has progressively lost their ecological and economic functions is commonly defined as wastelands.' (Joshi, 2003:1). There is no universally accepted definition of wastelands. Different agencies have used differing definitions, which has caused problems for generation of accurate database at the national level. The committee on wasteland survey and reclamation (1959) has classified wastelands 'as not available for cultivation, barren land and uncultivable waste, the uncultivable land excluding cultivable waste, permanent land under miscellaneous trees and fallow'. Society for the Promotion of Wasteland Development (1985) considers "wastelands as the land that is not producing green biomass consistent with the status of soil and water". Bhumbla (1984) defined "wastelands as those lands which are ecologically unstable, whose top soil has been completely lost or those which have developed toxicity in the root zone for growth of plants both annual crops and trees". This definition covers all land affected by water erosion, winds erosion, floods, water logging, soil salinization and soil alkalinization. However this excludes areas put to non-agricultural uses (village, roads, habitats, etc.) and land under miscellaneous tree crops and grooves.

National Wasteland Development Board set up a Technical Task Group (1986) to standardize the definition of wastelands, which is essential for securing the uniformity of database. The definition adopted was as follows, "Wasteland refers to the lands which can be brought under vegetative cover with reasonable effort and which is currently lying under utilized and land which is deteriorating for lack of appropriate water and soil management or on account of natural causes". This definition is generally considered satisfactory since it refers to the ecological factors underlying the erosion as also identifies the economic approach to deal with the problem. But many researchers and agencies have suggested some refinements and used their own definitions for estimating wastelands of India. 'The Wasteland Atlas of India' prepared by the NRSA (2000) for department of land resources states, "Degraded land which can be brought under vegetative cover with reasonable effort and which is currently underutilized. It also includes the lands, which are deteriorating for lack of appropriate water and soil management practices or on account of natural courses. Wasteland can result from inherent/imposed disabilities such as location environment, chemical and physical properties of the soil or financial or management constraints". Thus genesis of wastelands can be result of both natural as well as anthropological causes.

A large part of these degraded lands can be put to agricultural uses given that some efforts are made to reclaim them. If they are not reclaimed today they are likely to expand and influence the surrounding productive lands. Therefore, management of land resources is must for achieving our goal, self-sufficiency in food production and food security in the long run through sustainable agricultural development. Any attempt to develop the wastelands should address itself to the culturable wastelands, as unculturable wastelands by definition cannot be brought under productive use. But unculturable wastelands could well be used for other purposes such as urban development, establishment of industries etc.

1.3. Literature Review

There exists multifaceted literature on wasteland and their management for India as a whole, but studies on Rajasthan have been mostly carried out by agricultural scientists, botanist, geomorphologists etc.; which emphasize more on technical aspects rather than socio economic aspects of wastelands and their management. Socio-economic and environmental perspectives are equally important because degraded ecosystem threaten both the livelihood strategies and ecological services.

1.3.1. Role of Biophysical Factors

The fragile ecosystem of arid and semi arid lands is characterized by inherent variability. It is manifested in the episodic events that dominate seasonal, annual and long-term cycles. In these areas the processes operate as non-equilibrium or multi state systems that shift abruptly from one mode to another. Dry land soils have low resilience and the current and future capacity of the soils to support vegetation (Parry, 2000). Meteorological factors like mean annual rainfall, rainfall variability, water balance etc.

and edaphic indicators like effective soil depths, organic matter levels, nitrogen concentration levels, texture-structure characteristics etc. bear a significant relationship with vulnerability to desertification (Qureshi, 1994). The drought prone regions having fragile environmental conditions have greater underutilization of land than non-drought prone areas (Reddy, 1991). Some processes operate under desert climatic conditions like capillary action leads to transfer of salts to top soils, and cause salinization, but existence of hot dry climate is not in itself enough to set up salt accumulation and cause the formation of saline soils. With a deep ground water table (more than 10 meters), salinization doesn't occur in soils despite the dryness of the climate. Regions of salt accumulation lie in deep depressions, sometimes wholly or partially encircled by mountains chains or uplands (Raychaudhuri, 1978). Water logging and salinity have been observed to occur together in the Indira Gandhi Nahar Pariyojana (IGNP) region of Rajasthan (Jyotsna, 2003). Studies have taken note of the extent of problem and suggested various technologies for rehabilitation of wastelands and management of arid region resources with emphasis on drylands (Joshi, 2003; Ray and Upadhyay, 2004; Mann, 1979).

1.3.2. Population growth, Agriculture and environment

The relationship between population growth and environmental degradation is rather complicated and most debated. The most common interpretation is that accelerated population growth increases the pressure on food production system and available resources. Thus there occur an imbalance between population pressure and agricultural development as a result varying responses emerge. Various theoretical models have been devised to understand this, Malthusian model of Endogenous community (Gray and Moseley, 2005) i.e. growth of population would increase pressure on land leading to overutilisation and consequent degradation, leading to lowering of the productivity of land after reaching its carrying capacity, and Boserup's population driven technological progress model suggest that population growth would lead to intensive land use and thus greater wealth creation. But empirical evidences on contemporary less developed countries suggest that the population growth does not necessarily induce adjustment that on the whole that make it possible to meet growing food needs and to maintain agricultural income and land quality especially when there are already high population densities, strong political or economic inequalities, inappropriate policies or drought (especially when the natural environmental resource base in taken into account (Cuffaro, 1997).

The impact of population growth is resource specific. The increased population pressure accelerates forest conversion to agricultural uses but over a period of time the relationship weakens. This is because of alternate responses to population pressure in comparison to which deforestation is no longer a viable option, which are efforts to improve sustainable food production through intensification and permanent investment in land based capital (Zothers, 1999). Some studies have pointed out that intensification leads to wealth creation but scholars have pointed out that it may lead differential outcomes with wealthier farmers having an overall greater impact on the environment (Gray and Moseley, 2005). Tractorization had adverse effect on environment (jodha, 1986), which was adopted more by rich farmers. Further, increasing population pressure on land can lead to shortened fallow periods and this coupled with the farmer's inability to apply variable inputs intensively because of poverty can lead to decrease in soil productivity (Malik & Nazli, 1998). Climatic soil processes, population pressure, bush burning, cultivation and livestock rearing and over exploitation for fuel wood also contributes to land degradation (Sarpong, 1997). Common property resources like wastelands, forests, community pastures constitute an important natural resource endowment in rural areas of developing countries. In the absence of weakening regulatory institutions, rapid population growth may lead to degenerative patterns of use (like overgrazing) and gradual depletion of common property resources. Sometimes the effects of rapid population growth are mediated by institutional factors and often overshadowed by pressures arising from changing market conditions (Jodha, 1985). Population cannot be isolated as a singe causal variable for environmental degradation but a mediating factor, one of many that influence environment (Gray and Moseley, 2005). Poverty, environment and population are closely related and thus need to be looked at carefully.

1.3.3. Poverty and Environment

The relationship between poverty and environmental degradation is most controversial and debated. There is two way relationships between poverty and resource degradation. Poverty is said to be cause as well as the effect of resource degradation. The poor degrade the environment more due to their greater reliance on natural system and also due to their high discount rates of future returns consequent upon the absence of alternative income sources. This concept of 'vicious circle' has traditionally been used to explain poverty–environment relationship. But some scholars challenge the above contention, they say that since poor depend more on limited natural resource base they have greater motivation to conserve it. (Jodha, 1986) In the last few decades alternative explanations have emerged. These say that the perception of the 'vicious circle' as characterizing the environmental degradation and poverty is simplistic, exaggerated and misleading thesis (Nadkarni, 2000). It cannot capture the diversity of patterns and situations that exist in vast country like India. The specific resource (forest, land, water etc.) studied and the types of management strategies examined may affect conclusions on poverty–environmental relationship (Gray and Moseley, 2005). Studies blame the rich and powerful for greater environmental degradation. The activities of rich and powerful, combined with market and institutional failures are the primary factors forcing groups living at the margin into poverty (Duraippah, 1998). Wealthier farmers using capital-intensive technologies generally have an overall larger environmental impact (Gray and Moseley, 2005). And studies have also proved that tractorisation in agriculture have caused resource depletion in India (Jodha, 1985; Reddy, 1991).

1.3.4. Institutions and Natural Resource Management

Social institutions play an important role in creating and configurating natural environment and management. The state efforts to rationalize the landscape, irrespective of the traditional institutions set up may create problem for the local community as well as to the environment in the long run (Robins, 2001). The environmental status of four differently managed lands, *Gochars* (local state managed pastures), semi private Community fallow pastures, central-state forest department enclosures and *orans* (semi arid village forests) varies significantly. Forest enclosures are better managed than *orans* (locally managed) & *gochars* are poorly managed in comparison to community fallows (locally owned). The differing results are due to differing authority and producer response (Robbins, 1998).

The public policies and programmes after independence affecting wastelands ignored the fact that wastelands are the CPRs of village communities who recognize the economic and ecological contributions of these lands far better than policy makers. (Jodha, 2000). Rationalization and bureaucratization of landscape may lead to unforeseen environmental consequences that are beyond those of planner's designs (Robbins, 2001). So there shouldn't be strict separation of natural and social landscapes. In recent years, however the wasteland management programmes have accorded higher priority to participatory approaches, which is a positive step towards integrating natural and social landscape (Jodha, 2000). The question of change in property rights for efficient management also bears significance for common property resources because sustainability of natural resource base (agricultural production system) and ecosystem services are promoted by commons. The common property resources have positive externalities for environmental sustainability. Private ownership might lead to changes in favour of profitable agricultural land uses but may disturb the balance of ecosystem (Chopra, 2001).

Some research questions emerge from the literature reviewed above. These are:

1. Is degradation a natural process or induced by man?
2. Has the increased population pressure contributed to the degradation of agricultural environment?
3. Are the poor the agents of degradation or they are the victims of it?

4. Has overgrazing by ruminants resulted into the degraded land resources or they are the response to the degraded conditions where cattle find it hard to graze on the poor pastures & grasslands.
5. Do the property rights of common lands be transferred to private persons for efficient management or state and community should manage them?

Among these the first four have been looked at in this study given the limitation of data and level (scale) of analysis.

1.4 Study Region:

The study considers the state of Rajasthan, which occupies a significantly large portion of the Great Indian Desert. The issue of land degradation is very significant as far as the arid and semi arid areas are concerned because in these ecosystems drought is a regular part of the natural cycles. Rajasthan, the largest state of the country has largest proportion of its geographical area under cultivable wastelands (Chadha et. al.2004). Major factors responsible for this are climatic and edaphic factors that render it vulnerable to natural processes of degradation and anthropogenic activities in turn aggravate these. 69 percent of the area of Western Rajasthan lies in hyper arid and arid zone. Indian monsoon reaches here last and makes the earliest departure from western Rajasthan. Terrain is generally sandy and undulating sand hills in western Rajasthan and some alluvial plains and rugged hills in the east of Aravalli. Although usually the rainy season extends for a period of 3 months from 15^{th} June to 15^{th} Sept., precipitation effectiveness is confined to July and August. Rainfall variability is as high as up to 66 percent and draught occurrence is quite recurrent. Both the human and livestock population growth rate are considerably above the national average, and are very high in the western most districts of Jaisalmer and Bikaner. Overgrazing has rendered the rangelands vulnerable to degeneration. The present vegetation cover is poor with predominantly non-perennial species. The extension of canal irrigation in the northwestern parts of the state has led to remarkable increase in the agricultural production. But it has added to the problem of land degradation like water logging, salinity and alkalinity etc.

The state of Rajasthan falls under diverse agro climatic regions and sub regions (west arid, southern plateau, eastern plains, southern plains, north arid plains). The Western arid zone is characterized by hostile natural environment in comparison to semi arid and dry sub humid eastern plains, southern plans and southern plateau. Northern arid plain has been extensively put under canal irrigation South Eastern parts of state have ravines & gullied topography, thus the region have both natural and accelerated i.e. human induced factors of land degradation. Thus there are a number of causal factors for land degradation problems, and any single factor may not be directly responsible for such a critical problem. The region has recorded substantial increase in human and livestock population densities in the last half century, which has influenced the land use pattern also. Hence there is a necessity to explore the status of our understanding on the various causes & extent of land degradation in Rajasthan.

1.5. Objectives

1. To analyze the spatio-temporal trends in cultivable wastelands in Rajasthan during 1980-81 to 2000-01.
2. To identify the determinants of spatial variations of cultivable wastelands in Rajasthan.
3. To critically review the programmes and policies of wasteland development in Rajasthan.

1.6. Database

Indicators	Source
(1) Cultivable Wasteland	Agricultural Statistics & Basic Statistics, Rajasthan, NRSA, ARPU Report
(2) Rainfall and Rainfall Variability	Basic statistics of Rajasthan, IMD archives.
(3) Livestock density	Livestock census
(4) Poverty Ratio	Rajasthan Human Development Report 2002
(5) Land-man ratio	To be calculated from census data.
(6) Average size of operational holdings	Statistical Abstract, Rajasthan
(7) Gross irrigated Area	Agricultural statistics
(8) Expenditure on watershed development and soil conservation measures	Districtwise Expenditures and Physical Achievements, Seventh and Nineth Five-Year Plan, Planning Department, Government of Rajasthan, Secretariat,jaipur

1.7. Analytical Framework

This study is an empirical analysis of degraded land and their determinations in Rajasthan at district level for the period 1980-81 to 2000-01.

Period of study has been so chosen because we need a considerably long period of time to see the status of degraded lands, as land degradation is a long tern phenomenon. Further the natural and human factors that affect it change significantly over long periods of time and their effects are visible cumulatively. Several efforts for development of wasteland were made through launch of National watershed development programme for rain fed areas (NWDPRA), Integrated wasteland development programme (IWDP) etc. in 1980s and continued after that Thus there is a case to analyze the trend of extent & status of wasteland over this time period.

District is the smallest unit of administration at which all data relating to socio-economic indicators are available. Further it is an important planning unit and most of the funds flow from centre and state to the districts.

Indicators used in the study:

Land degradation:

(1) Cultivable wasteland and Fallow other than current fallow have been added to obtain total cultivable wasteland. Current fallow have been excluded as its extent in Rajasthan mostly depend upon the fluctuations of rainfall.

Further barren and uncultivable wastelands have been excluded as they do not represent a future stock of agricultural land and are almost entirely determined by natural processes.

Determinants: Indicators

(i) Rainfall

(ii) Rainfall variability

(iii) Livestock density

(iv) Human poverty ratio

(v) Land–man ratio

(vi) Average size of operational holding

(vii) Gross irrigated area as percentage of total geographical area

1.8. Organization of chapters

Chapter 1. Introduction

Chapter 2. Spatio-Temporal Trends of Cultivable Wastelands in Rajasthan

Chapter3. Determinants of Underutilization and Land Degradation in Rajasthan

Chapter 4. Policies and Programmes for Land Management in Rajasthan

Chapter 5. Conclusions

CHAPTER-II

Spatio-Temporal Trends of Cultivable Wastelands in Rajasthan

2.1. Introduction

Wastelands are the lands, which have progressively lost their ecological and economic functions. These are caused by the unscientific use of the land resources. The conversion of healthy land to degraded land largely depends upon the man-environment interactions in an area, which vary from one region to another. The problem is of immense nature in some regions particularly in fragile ecosystem of Indian desert region. The spatial aspects of wastelands need to be studied fully to understand the dynamics of wastelands. Various efforts have been made by the government to reduce this gross underutilization prevalent in the region from time to time. Thus there is rationale of temporal analysis of the status of underutilized and degraded lands. This chapter has following objectives:

(i) To analyze the spatial patterns of underutilized and degraded lands.

(ii) To compare various estimates of cultivable wastelands in Rajasthan

(iii) To analyze temporal trends of underutilized lands.

2.2. Extent of wastelands:

The exact extent of wastelands in India has hardly been assessed. The figures presently available from different sources are only rough estimates or technical assumptions. A number of agencies like society for promotion of wastelands (SPWD), Ministry of Agriculture (MoA), National Remote Sensing Agency (NRSA) etc. have made attempts to determine the extent of wastelands either by way of complication of available data or by resorting to mapping wastelands from satellite imagery and ground interpretations. According to the Ministry of Agriculture, Govt. of India statistics out of the total 329 million hectares of geographical area, 175 million hectares is affected by degradation leading to formation of wastelands. The NRSA estimates for total area studied, reports 63.85 million hectares of wastelands (excluding 12 million hectares of area of Jammu and Kashmir) and thus nearly 20 percent of the geographical area of country under wastelands. The SPWD estimates of wastelands come to 93.69 million hectares. These differences are mainly because of the definitional variations and methodology adopted.

Rajasthan have largest proportion of cultivable wasteland in the country. The land use statistics for 2000-01 of Rajasthan presents following picture:

Table 2.1: Land use in Rajasthan 2000-01

Category	Area (lakh ha)	Percent of reported area
Reporting area for land use purpose	342.64	100
i. Forest	26.06	7.60
ii. Land put to non-agricultural use	17.39	5.07
iii. Barren & uncultivated lands	25.66	7.49
iv. Permanent pastures & other grazing land	17.07	4.98
v. Land under miscellaneous tree crops & grooves	0.14	0.04
vi. Cultivable waste	49.08	14.32
vii. Fallow other than current fallow	24.44	7.13
viii. Current fallow	24.15	7.05
ix. Net area sown	158.65	46.30
x. Area sown more than once	33.65	9.82

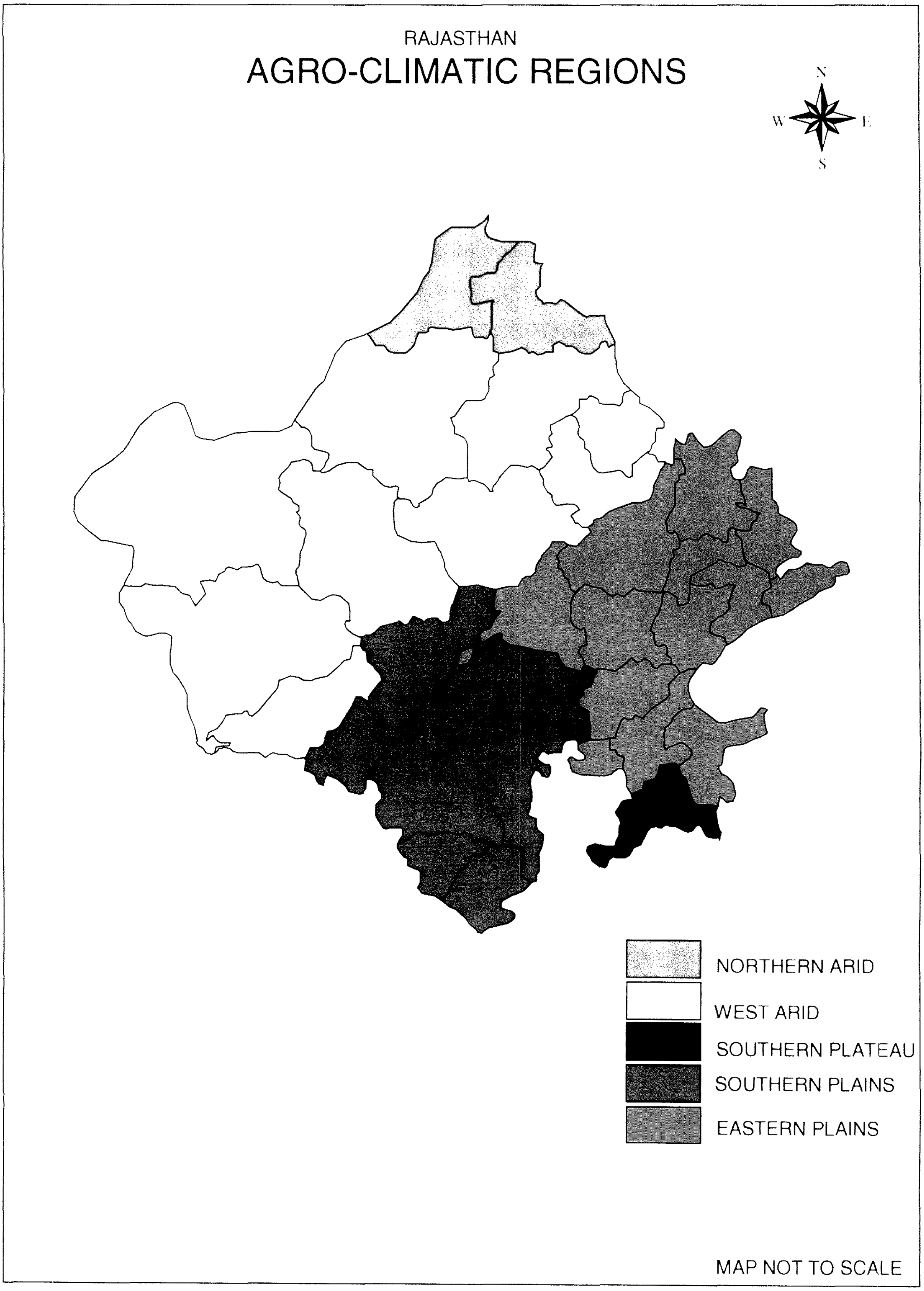
Source: Basic statistics Rajasthan 2001

2.3. Spatial Distribution of Cultivable Wastelands in Rajasthan

The culturable wastelands are those, which are available for cultivation but have not been taken up for cultivation owing to their uneconomical farm returns or they have been abandoned after a few years of use for one reason or the other. These lands are mostly in the form of water logged lands, ravines and gullies, sand dunes, degraded forests; land with or without scrub etc. Rajasthan have highest percentage of total geographical area as culturable waste (14.57 percent of the geographical area). In Rajasthan, most of the western and north western districts like Jaisalmer and Bikaner have culturable wastelands on account of a thick mantle of permanent sand dunes which are often 20 to 40 metres high and 2 to 6 km long (Joshi, 2003) They have sparse foliage cover of xerophytes including dwarf trees like Khejari (prosopis cineraria). These lands have potential for development of pastures as well as for horticulture.

There are two comprehensive sources of wastelands data. The one is based on land use data collected by Directorate of Economics and Statistics, Government of Rajasthan, out of the total nine categories of land uses reported, culturable waste and fallow other than current fallow are of considerable interest to us. Current fallow are left vacant to regain fertility and in Rajasthan its extent depends upon rainfall availability in a given year because the irrigation facilities are available in less than one third of the net sown area in the state. This data enables us to have regular and annual estimates of culturable wasteland. But this does not elaborate the types of wastelands and any idea about causal process. These shortcomings are to some extent overcome by another estimate, 'Wasteland Atlas of India' generated by National Remote Sensing Agency (NRSA) for department of land resources, is most comprehensive and exhaustive estimates of wastelands in India till date. NRSA classifies wastelands into 13 categories; out of which 10 categories have been included into cultivable wastelands and rest are barren and uncultivable wastelands.

MAP.2.1


RAJASTHAN
AGRO-CLIMATIC REGIONS
N
W
E
S
NORTHERN ARID
WEST ARID
SOUTHERN PLATEAU
SOUTHERN PLAINS
EASTERN PLAINS
MAP NOT TO SCALE

2.3.1. Culturable waste

According to the Directorate of Economics and Statistics, Government of Rajasthan, land use data culturable waste occupies 14.57 percent of the total geographical area in the state in 2000-2001. Although there are significant spatial variations in their distribution, western Rajasthan account for 78 percent of the total culturable wastelands in the state. The major contributor here is the sand dunes, which are devoid of any vegetation cover. Jaisalmer with 70.77 percent of its geographical area has highest extent of culturable waste whereas lowest is in Bharatpur (0.57percent). The agro-climatic sub-region wise distribution (table 2.2) shows that highest proportion of geographical area under culturable waste is in the west arid region (22 percent), followed by the southern plains region (10.60 percent) and southern plateau region (8.84 percent) consisting of Jhalawar district. The eastern plains agro-climatic zone of the state has low area under culturable waste. These districts have significantly higher net sown area and high population pressure coupled with good rainfall. Similarly the northern arid region has very low culturable waste, as it is command area of Rajasthan canal.

Table2.2
Distribution of Cultivable Wastelands in Rajasthan
(2000-2001)

ACRP / District	TCWL	FOCF	CWL
Northern arid	10.72	8.06	2.66
Ganganagar	20.15	14.31	5.84
Hanumangarh	4.77	4.11	0.66
Southern Plains	18.58	7.98	10.60
Banswara	15.27	10.82	4.45
Bhilwara	22.48	6.87	15.61
Chittorgarh	21.05	4.82	16.22
Dungarpur	14.68	8.26	6.42
Pali	11.82	8.05	3.77
Rajsamand	42.41	12.24	30.17
Sirohi	11.91	10.16	1.75
Udaipur	17.83	8.14	9.69
Eastern Plains	7.64	3.65	3.99
Ajmer	16.51	7.41	9.10
Alwar	2.55	1.47	1.08
Baran	6.30	2.42	3.89
Bharatpur	2.12	1.55	0.57
Bundi	11.76	5.79	5.97
Dausa	4.57	1.90	2.67
Dholpur	7.15	3.20	3.96
Jaipur	7.53	4.83	2.70
Karauli	4.69	2.15	2.54
Kota	7.53	2.62	4.91
S.Madhopur	5.23	2.80	2.43
Tonk	10.76	4.41	6.34
Southern Plateau	12.06	3.22	8.84
Jhalawar	12.06	3.22	8.84
West Arid	31.40	9.25	22.14
Barmer	26.46	17.09	9.37
Bikaner	39.07	10.19	28.88
Churu	5.57	4.68	0.89
Jaisalmer	74.06	3.29	70.77
Jalore	17.39	14.38	3.01
Jhunjhunu	5.15	4.14	1.01
Jodhpur	16.79	14.97	1.81
Nagaur	6.22	5.46	0.76
Sikar	6.74	5.46	1.27
Rajasthan	**22.18**	**7.61**	**14.57**

Source: Computed from Land use Statistics of Rajasthan

2.3.2. Fallow other than current fallow:

The percentage of fallow lands in Rajasthan is extremely high (14.18percent) showing that the farmers have to leave the lands uncultivated for longer duration to regain fertility. The break up of fallow land into current fallow (7.13 percent) and fallow other than current fallow (7.6 percent) gives better insight. The current fallow is not problematic because they are left uncultivated by the farmers to regain fertility in a year. Its extent depends upon rainfall availability in a given year because the irrigation facilities are inadequate i.e. agriculture is rain fed hence failure or late onset of monsoon rainfall in any year leads to large area being left as fallow. The other types of fallow lands, which are left vacant for more than a year, are of great concern to us. Thus we can see that nearly 22 percent of the total geographical area is almost permanently out of cultivation because of poor management practices (Chadha, et.al.2004) and traditional farming techniques (Joshi, 2003). The spatial distribution of fallow other than current fallow shows large spatial variations. Barmer (17.09 percent), Jodhpur (14.97 percent), Jalore (14.38 percent) have high percentage of their geographical area under fallow other than current fallow. Alwar (1.47 perecnt) and Bharatpur (1.55 percent) districts have low fallow land other than current fallow. These districts have higher amounts of annual rainfall and mostly these are fertile plains. The agro climatic zone wise their distribution shows much resemblance with that of culturable waste. Thus we can see that there is a distinct pattern of distribution of fallow other than current fallow in Rajasthan.

Together the above two categories account for total underutilized (Reddy, 1991) lands and occupy 22 percent of the geographical area of the state. These two categories combined, hereafter called as total cultivable wasteland (or 'underutilized lands' (Reddy,

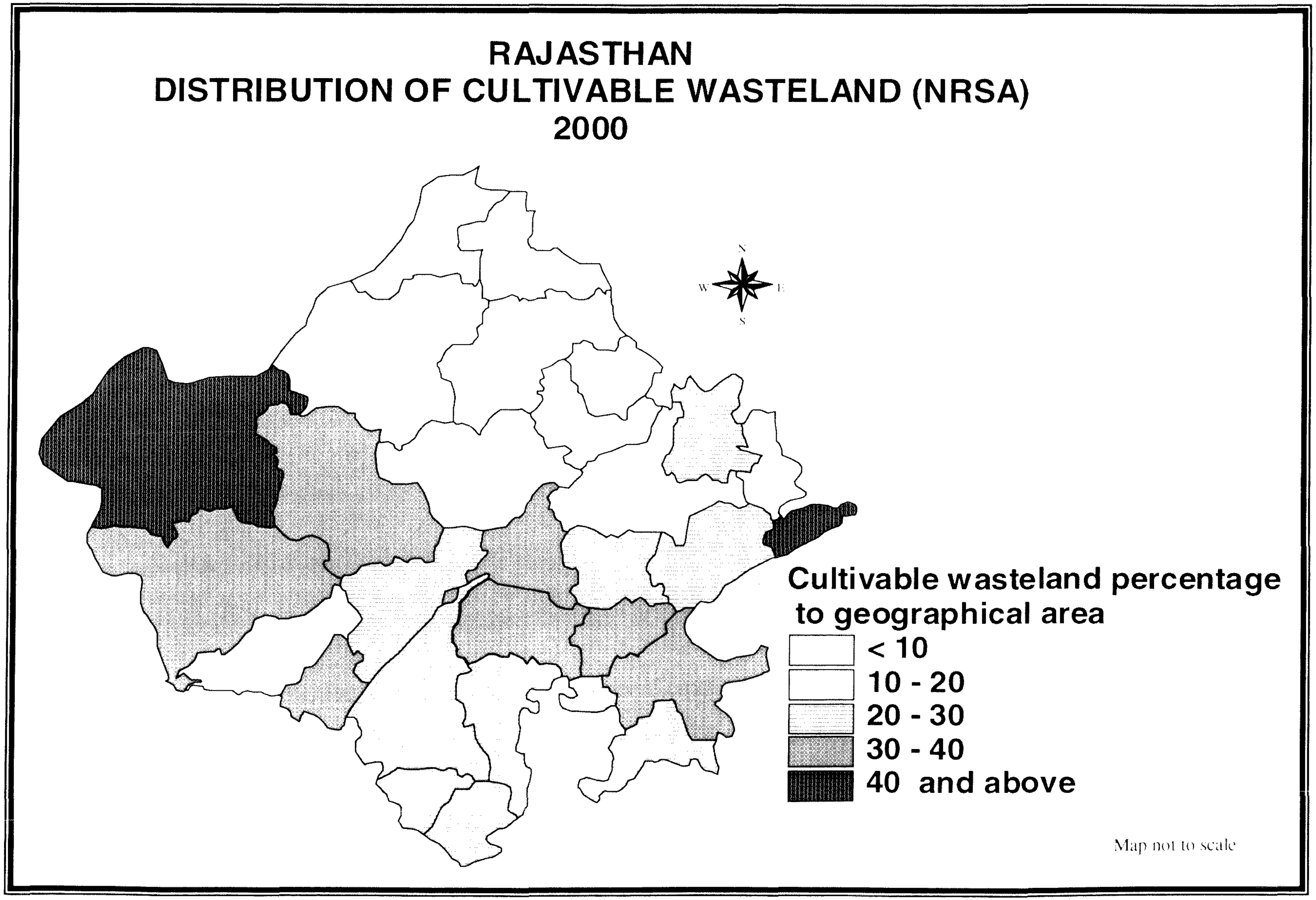
1991) vary significantly across space. The districts of western Rajasthan like Jaisalmer (74.06 percent), Bikaner (39.07percent), Barmer (26.46 percent) and Jodhpur (19.27 percent) have significantly higher percentage of such lands to their total geographical area. Agro climatic zone wise their extent is highest in west arid region (31 percent) followed by southern plains (18 percent) southern plateau and northern arid (Table 2.2). The eastern plains region has least proportion of its area as underutilized lands. Thus one of the major tasks before the policy makers is to prevent this underutilization of land resources of the state.

The Ministry of Agriculture estimate on wastelands does not give a comprehensive classification of wastelands. It does not show various categories of wastelands, which are result of various causal processes.

NRSA 'Wastelands Atlas' (2000) gives a broad classification of wastelands into 13 categories out of which 10 categories are included in cultivable wastelands whereas remaining three being uncultivable. These classes give us an idea about causal process also. The NRSA scheme is as follows:

I. Gullied and ravinous land
II. Land with or without scrub
III. Waterlogged and marshy land
IV. Land affected by salinity / alkalinity coastal / inland
V. Shifting cultivation area
VI. Under utilized / degraded notified forest land
VII. Degraded pastures / grazing land
VIII. Degraded land under plantation crops
IX. Sands – Desertic / Coastal
X. Mining / industrial wasteland

MAP 2.II


RAJASTHAN
DISTRIBUTION OF CULTIVABLE WASTELAND (NRSA)
2000
N
W
E
S
Cultivable wasteland percentage
to geographical area
< 10
10 - 20
20 - 30
30 - 40
40 and above
Map not to scale

XI. Barren rocky / Stony waste / sheet rock area.

XII. Steep sloping area

XIII. Snow covered and / or glacial area

According to NRSA estimates wastelands occupy 30.87 percent of the total geographical areas of the state out of which 29.40 percent are cultivable wastelands (ten categories of NRSA classification-CWL (10)). The spatial distribution of cultivable wastelands (CWL (10)) shows wide variations, with very high proportion of geographical area in the west arid (34 percent) and southern plateau (29.8) agro-climatic zones. The lowest extent is in northern arid agro-climatic zone (10 percent). The district wise analysis shows very high concentration of these lands in Jaisalmer (87 percent) and dholpur (45 percent). Hanumangarh (3.69 percent) have lowest extent of cultivable wastelands (map 2.II).

Further, we can narrow down the NRSA estimates of cultivable wastelands by excluding two categories, gullied and ravinous land, and mining and industrial wastelands. These two categories are to be excluded based on limited technological and economic feasibility of bringing such land under cultivation (Chadha, et.al. 2004). After such adjustment the cultivable wastelands (CWL (8)) account for 25.84 percent of the total geographical area of the state. Their spatial pattern also reveal same pattern as that of CWL (10).

Table 2.3
Cultivable Wastelands in Rajasthan (NRSA)

District	CWL(10)	CWL(8)	CWL(6)
Northern arid	**10.26**	**9.70**	**9.69**
Ganganagar	16.04	16.04	16.04
Hanumangarh	3.69	2.49	2.47
West arid	**34.34**	**30.53**	**29.53**
Barmer	32.43	25.87	25.86
Bikaner	12.44	9.69	9.38
Churu	9.74	2.04	2.00
Jaisalmer	87.74	87.31	87.31
Jalore	10.48	9.15	8.62
Jhunjhunu	14.12	9.25	4.20
Jodhpur	30.15	24.45	23.94
Nagaur	12.87	7.28	6.93
Sikar	16.83	5.01	3.42
Southern plains	**25.75**	**16.06**	**16.70**
Banswara	22.04	18.88	18.84
Bhilwara	30.53	14.10	13.80
Chittorgarh	23.23	16.61	15.60
Dungarpur	27.65	21.98	21.98
Pali	25.41	13.46	13.33
Sirohi	34.97	11.78	10.72
Udaipur	22.60	21.59	21.55
Eastern plains	**26.25**	**12.86**	**7.69**
Ajmer	37.92	25.17	23.69
Alwar	21.73	10.29	7.76
Bharatpur	11.36	10.15	7.74
Bundi	37.96	16.31	8.78
Dholpur	44.94	40.31	24.72
Jaipur	19.83	12.09	5.95
Kota	30.90	5.83	0.81
S.Madhopur	22.99	9.38	1.49
Tonk	20.74	7.87	5.12
Southern plateau	**29.82**	**9.54**	**5.63**
Jhalawar	29.82	9.54	5.63
Rajasthan	**29.40**	**25.84**	**20.85**

Source: Computed from NRSA Wasteland Atlas, 2000.

Another estimate of cultivable wasteland can be obtained by excluding two more categories, 6 and 7 i.e. under utilized / degraded notified forest land and degraded pastures/ grazing land. The community or forest department either owns these categories of land. Further, these lands are known to prove useful for the community a whole and thus they should not be brought under cultivation (Chadha, et.al. 2004). This third estimate of cultivable wastelands (CWL (6)) extends over 20.84 percent of the total geographical area of the state.

2.4. Types of Wastelands

Desertic sands: In Rajasthan, most of the areas of the western and north western districts like Jaisalmer and Bikaner have culturable wastelands on account of a thick mantle of permanent sand dunes which are often 20 to 40 metres high and 2 to 6 km long. The vegetation cover is very poor on these sand dunes. These are largest category of wasteland in Rajastahn. Churu, Bikaner, Barmer, Jaisalmer, Sikar, Jodhpur, Jalore, JhunJhunu.

Gullied and Ravinous land: Ravines are mot extensive in the districts of Sawai Madhopur, Kota, Bundi, Dholpur. These mainly occur along the banks of Chambal and its tributaries. Leveling of these lands to bring them under plough is a gigantic task, which is economically not feasible. In Rajasthan most land consists of loose coarse sand that can be easily washed away in times of heavy downpour making way for further streamlets.

Land with or without scrubs: Constitute a significantly high (38.34perecnt) proportion of the total cultivable wasteland of the state. They are most prominent in Dholpur Udaipur, Jhalawar, Alwar, Dungarpur, Kota, Sawai Madhopur, Banswara, Bhilwara, Bundi, Chittorgarh. Thus we can say that land with or without scrub predominantly occurs in the districts of southern and southeastern districts of Rajasthan.

Waterlogged and Marshy land: Waterlogged lands are not much in the state although the problem exists along the course of some rivers. In Gangangar, Hanumangarh, Bikaner districts the problem exists because of inappropriate canal irrigation techniques. Kota and Bharatpur are other districts that have recorded wastelands on account of water logging.

Saline and Alkaline soils: In arid climates the salts do not leach down very much below the topsoil horizon. Since the amount of rainfall is small, but the evaporation is very rapid, the process of salinization is extremely rapid. In such areas under irrigated conditions, the excessive use of irrigation water accentuates the process of salinization. As the water from the surface evaporates, water brings up salts by capillarity from lower horizons, where they accumulate in quantities larger than can be dissolved by flush of rain water. These soils cover significant areas in the districts of Ajmer, Jaipur, Pali, Tonk, Chittorgarh, and Sikar.

2.5. Wastelands by causal process

The 13 categories of wastelands (NRSA) can be further sub divided into three broad categories– natural, natural processes accelerated by man and man made. Gullied/ravinous land, desertic or coastal sands, barren rocky area, steep sloping land and glacial area are mainly caused by natural agents. The latter three categories are uncultivable and barren and hence can be excluded.

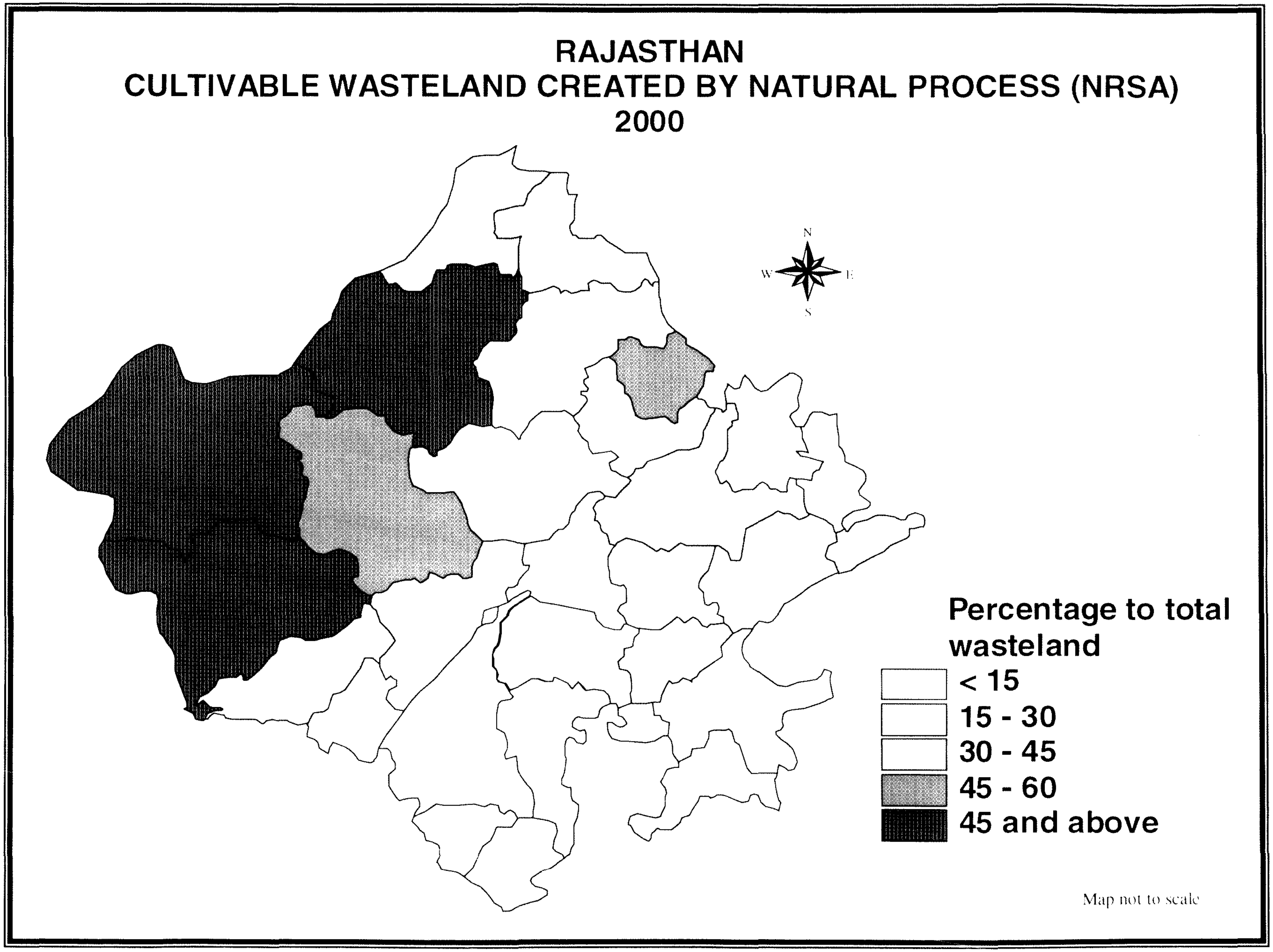
Table 2.4

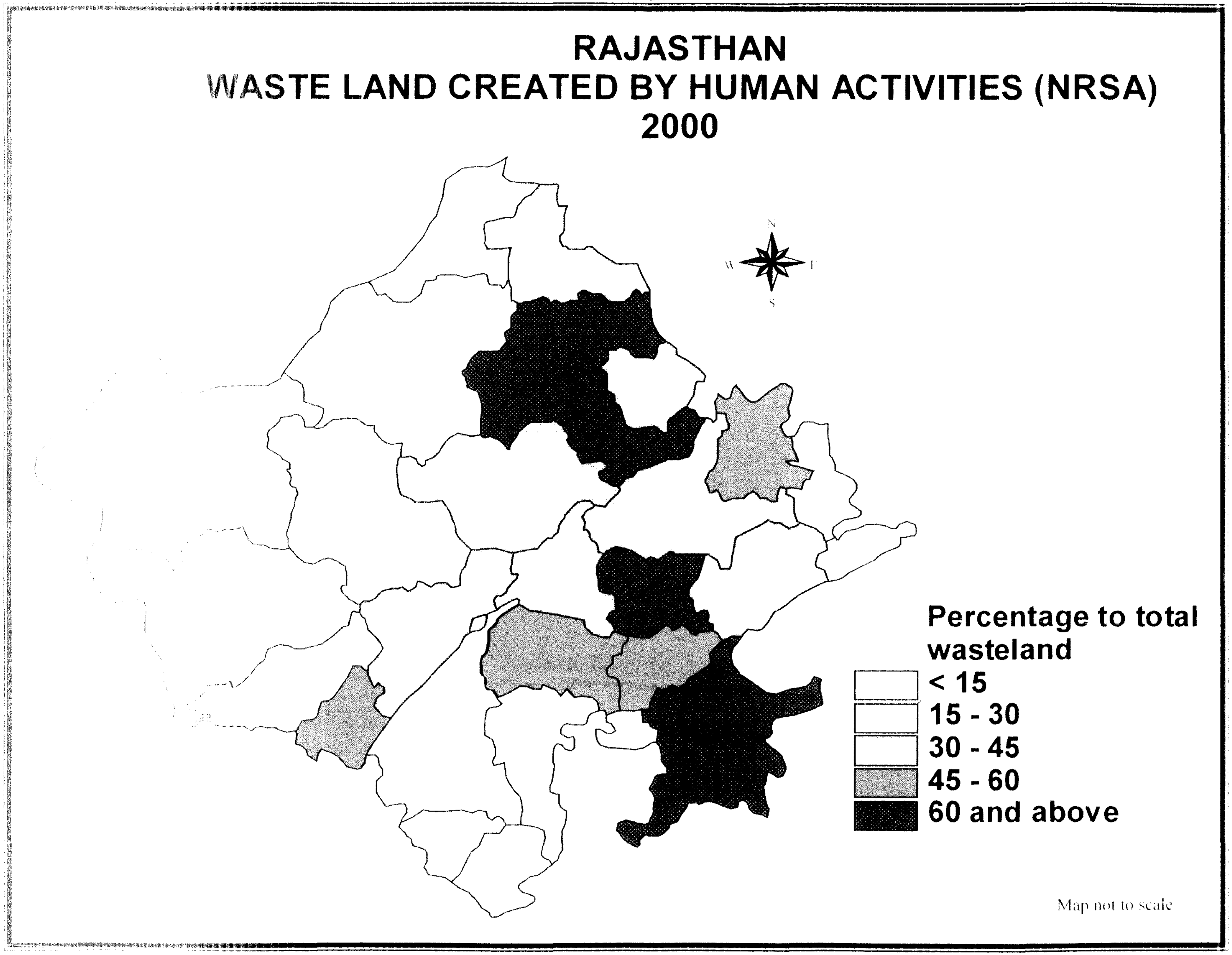
Classification of Degraded Lands by Causal Processes

ACRP / District	Natural	Natural plus Manmade	Man Made	Uncultivable
Northern arid	39.83	54.58	5.59	0.00
Ganganagar	41.06	58.94	0.00	0.00
Hanumangarh	33.73	33.07	33.20	0.00
west arid	64.23	20.74	12.56	2.46
Barmer	62.05	15.24	19.64	3.07
Bikaner	64.07	13.45	22.48	0.00
Churu	19.41	1.13	79.39	0.07
Jaisalmer	76.40	20.51	0.48	2.62
Jalore	39.66	38.46	11.38	10.49
Jhunjhunu	48.73	15.87	34.07	1.32
Jodhpur	45.77	33.90	19.02	1.30
Nagaur	23.41	30.84	42.86	2.88
Sikar	20.77	8.49	68.94	1.80
Southern plains	2.20	59.15	31.62	7.02
Banswara	0.19	82.98	13.91	2.92
Bhilwara	0.95	37.97	45.31	15.78
Chittaurgarh	4.10	62.98	26.73	6.18
Dungarpur	0.00	77.39	22.56	0.06
Pali	2.11	48.49	44.95	4.46
Sirohi	8.38	20.15	56.68	14.79
Udaipur	0.04	95.23	4.60	0.13
Eastern plains	20.09	23.87	46.28	9.76
Ajmer	5.78	58.14	32.44	3.64
Alwar	10.94	30.37	46.51	12.18
Bharatpur	20.70	64.74	10.24	4.33
Bundi	17.62	20.58	50.73	11.07
Dholpur	34.50	54.76	10.30	0.43
Jaipur	43.23	16.15	38.24	2.37
Kota	14.24	2.47	77.20	6.09
Sawai Madhopur	23.89	4.04	40.56	31.51
Tonk	18.10	19.26	61.15	1.49
southern plateau	12.58	18.14	65.32	3.96
Jhalawar	12.58	18.14	65.32	3.96
Rajasthan	**43.16**	**28.56**	**23.57**	**4.54**

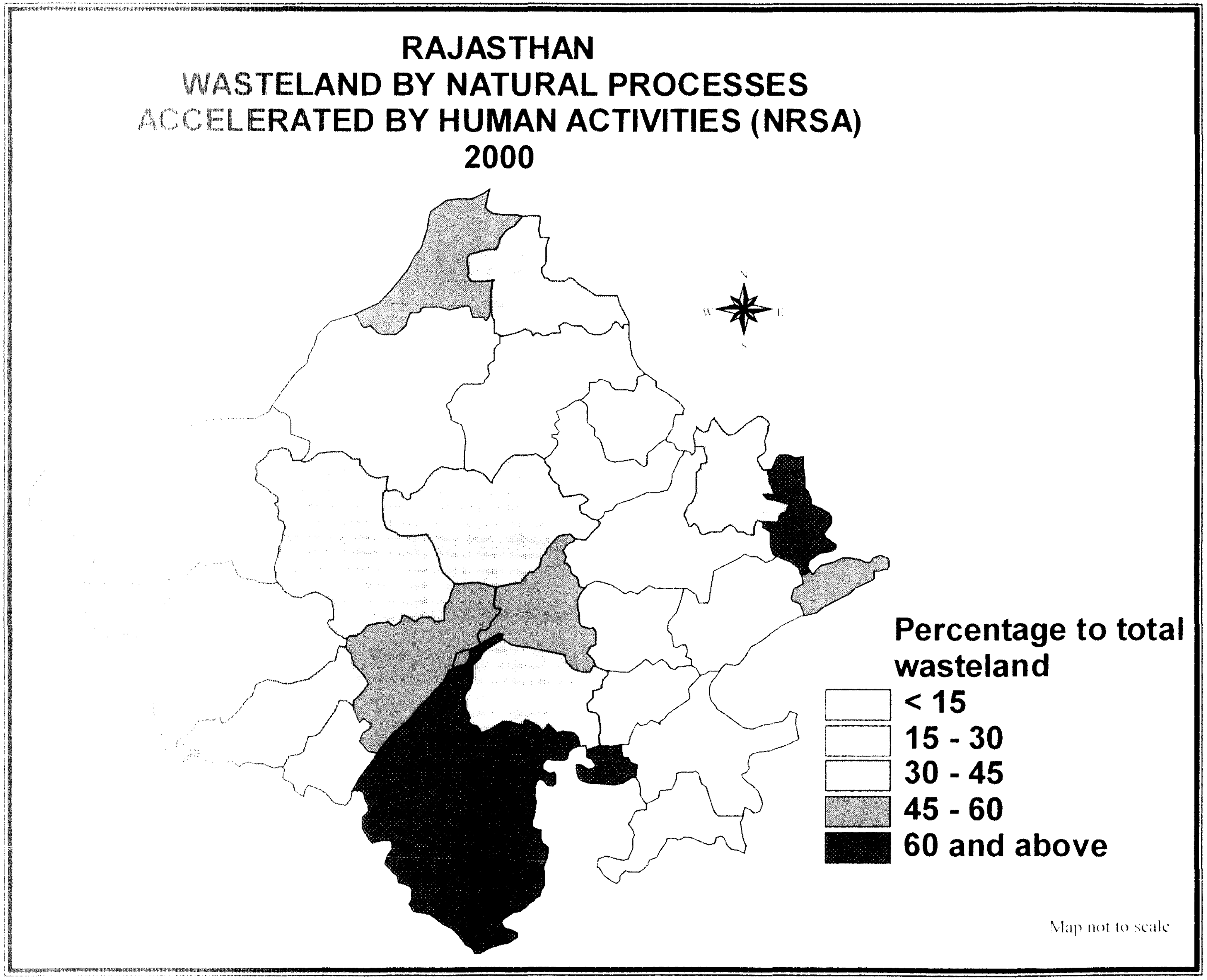
Source: Computed from Wasteland Atlas of India

MAP 2.III


RAJASTHAN
CULTIVABLE WASTELAND CREATED BY NATURAL PROCESS (NRSA)
2000
N
W
E
S
Percentage to total wasteland
< 15
15 - 30
30 - 45
45 - 60
45 and above
Map not to scale


RAJASTHAN
WASTE LAND CREATED BY HUMAN ACTIVITIES (NRSA)
2000
N
W
E
S
Percentage to total wasteland
< 15
15 - 30
30 - 45
45 - 60
60 and above
Map not to scale

MAP 2.V



RAJASTHAN
WASTELAND BY NATURAL PROCESSES
ACCELERATED BY HUMAN ACTIVITIES (NRSA)
2000
Percentage to total wasteland
< 15
15 - 30
30 - 45
45 - 60
60 and above
Map not to scale

Some categories like waterlogged and marshy area, land affected by salinity and alkalinity, and land with or without scrub can be caused by natural and man made factors both. Here natural processes plays primary role but human agency can accelerate them.

Certain other categories like degraded shifting cultivation area, degraded land under plantation area, degraded forest, degraded pastures and mining and industrial wasteland are caused by human agents.

All the three above-mentioned broad categories occur in Rajasthan (Table 2.4). The dominant is natural process accounting for 43 percent of the total cultivable wasteland (Table 2.4) followed by natural process accelerated by human agent (28.56 percent) and human agent solely responsible for degradation (23.57 percent).

The causal processes are specific to any locality and generally depend upon environmental conditions and man nature interaction. The degraded lands created by natural processes are dominant in west arid region with some presence in the northern arid region (map 2.III) while those created by natural processes accelerated by human activities are dominant in northern arid and southern plains (map 2.IV). The degraded lands, which are purely result of human activities, are dominant in southern plateau, eastern plains and marginally present in southern plains (map 2.V). Thus we see that from west to east the dominance of causal processes shift from natural in the west to natural processes accelerated by human activities to south and then to purely human activities in the southern plateau, eastern plains and marginally in southern plains.

2.6. Comparison of the two wasteland estimates

When we compare the total cultivable wasteland (obtained by aggregation of culturable waste and other than current fallow land) and non-forest cultivable wasteland data (obtained by aggregation of eight categories out of the total ten cultivable wastelands categories in the NRSA 13 fold categories, categories vi and vii have been excluded.)

Table 2.5

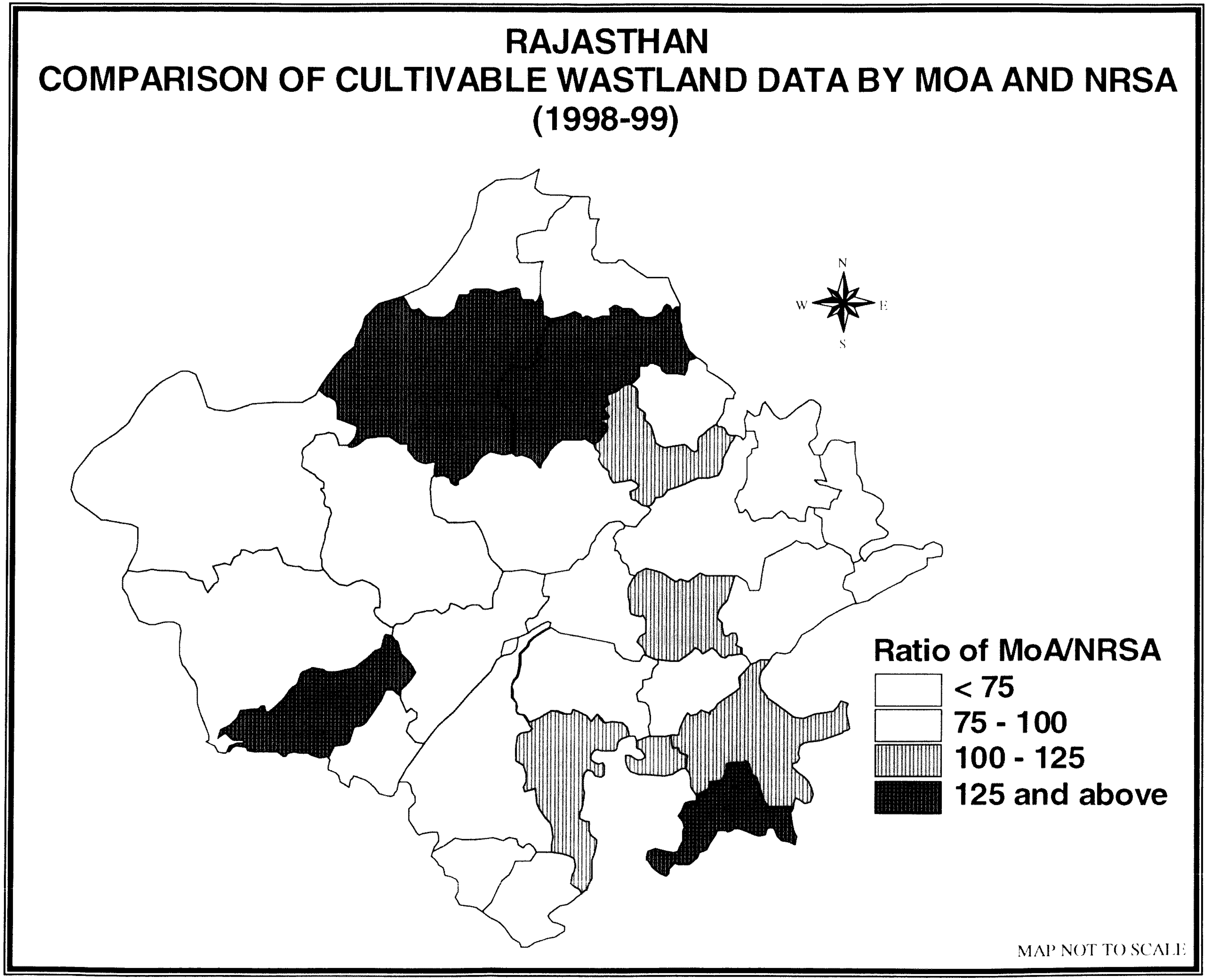
Comparision of Wasteland Estimates by MoA and NRSA

(1998-1999)

District	MOA	NRSA	MoA/NRSA
Ganganagar	132891	200116	66.41
Barmer	727113	734413	99.01
Bikaner	1053046	147456	714.14
Churu	95495	34261	278.73
Sikar	47872	38775	123.46
Jaisalmer	2881764	3352800	85.95
Jalore	154516	97352	158.72
Jhunjhunu	23076	54840	42.08
Jodhpur	466659	558768	83.52
Nagaur	96663	128997	74.93
Pali	147533	166703	88.50
Banswara	61080	95103	64.23
Bhilwara	234230	264122	88.68
Dungarpur	57993	82856	69.99
Sirohi	45670	60480	75.51
Chittorgarh	206892	180354	114.71
Udaipur	336676	373053	90.25
Bundi	54210	90503	59.90
Kota	89730	72504	123.76
Ajmer	117770	213425	55.18
Tonk	62948	56586	111.24
Jaipur	87907	170078	51.69
Alwar	20841	86261	24.16
Bharatpur	11974	51669	23.17
S.Madhopur	44119	98715	44.69
Dholpur	21760	121260	17.94
Jhalawar	76092	59328	128.26
Rajasthan	7356520	7588634	96.94

Source: Computed from Wasteland Atlas of India, Basic Statistics: Rajasthan, 2000

MAP 2.VI


RAJASTHAN
COMPARISON OF CULTIVABLE WASTLAND DATA BY MOA AND NRSA
(1998-99)
N
W
E
S
Ratio of MoA/NRSA
< 75
75 - 100
100 - 125
125 and above
MAP NOT TO SCALE

The former comes to 96.91 percent of the NRSA estimates at the state level and significant inter district variations (Table.2.5). The districts of western Rajasthan show less of the mismatch and the percentage between the two (MoA/NRSA) between 80-100 percent, except the four districts of districts which have very high MoA estimates than NRSA (map 2.VI). These show abnormally high MOA estimates, because the remote sensing imagery estimates by NRSA may have misinterpreted, because of the timing of the imagery. The imagery if taken at a time when crops have been harvested then it will show high current fallow. The districts of eastern Rajasthan and Ganganagar, hanumangarh districts of northern Rajasthan have less of the MoA estimates than that of NRSA. These districts have favourable resource endowments and better irrigation infrastructure. Thus here is less risk of crop failure. This serves as motivation for the farmer to put otherwise degraded lands under some use. These variations can be explained on the basis of which the data is collected/generated. MoA data is based on farmer's reporting to the *patwari* which involves considerable subjectivity on the part of the reporting person, whereas remote sensing data is based on the bio-physical properties of the land features.

Thus there may be difference between how a person assesses a given land and its actual bio-physical properties. The farmer's perception is influenced by productivity of land in the region, agricultural infrastructure and ecological fragility of the region. The assumption here is that overall high productivity in area, developed agricultural infrastructure and less fragile ecology (environment) provides some incentives for farmers to under take some land development measures at their own. Thus he may perceive the bio physically degraded land as a part of net sown area. The correlation hectare, rainfall shows significant negative correlation, with value of correlation coefficient being –0.49 and –0.35 significant at 1 percent and 10 percent level respectively.

Similarly we assume that infrastructural development in region is bound tc increase the more intensive use of agricultural land and thus the farmer can think of taking minor land reclamation measures at his own and bring otherwise biophysically degraded land under some use and hence he may not perceive it to be degraded. Thus reported reported degraded and partially degraded lands (culturable waste and long term fallow) less than the estimates based on purely physical properties of land (irrigated area as percentage of gross cropped area and road length per 100 sq. kilometres bear significant negative relationships with the ratio of MoA/NRSA, at five percent of level significance($r = -0.42$ and -0.44 respectively).

2.7. Temporal Trends

Land use undergoes changes over a period of time because of changes in socio-economic conditions. The underutilized lands (total cultivable wasteland) have declined over the period 1980-2001 from 25.16 percent of geographical area to 19.87 percent. Culturable waste separately have recorded maximum decline from 18.75 percent to 13.16 percent. Fallow other than current fallow have recorded only marginal decline. This is because the lands have to be left vacant for longer duration to regain its fertility in the state. Further the economy of the region is mainly agro-pastoral (contribution of livestock to state domestic product it is next to agriculture, the farmers even graze their livestock over the other than current fallow during the kharif crop season. This is partly because of the increasing pressure on the village common property resources and consequent deterioration of their health. Thus we can see that major decline out of the underutilized lands have been recorded in this category.

Table 2.6

Changes in the Land Use Pattern of Rajasthan during the period 1980-2001*

(Increase and Decrease in terms of percentage of geographical area.)**

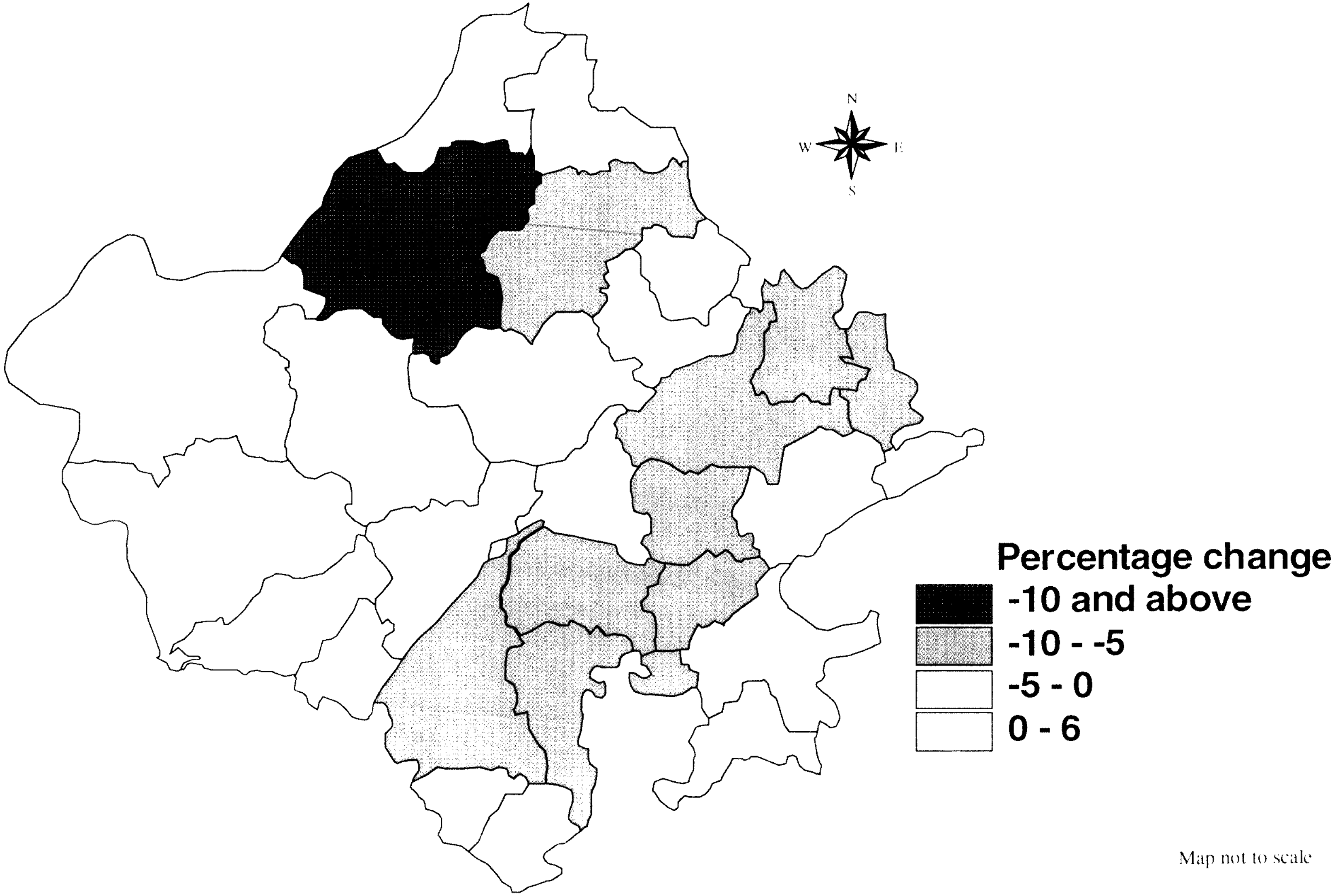
	Forest	NAU	CWL	FOCF	CF	NAS	BAUC	PAST	MISC.	TCWL
Ganganagar	2.28	0.85	-10.01	3.98	4.07	-0.69	0.45	-0.79	-0.16	-4.59
Barmer	0.45	0.41	-3.13	5.46	2.96	-5.51	-0.30	-0.35	0.00	2.56
Bikaner	1.99	4.22	-22.29	3.88	2.13	8.24	1.14	0.25	0.00	18.63
Churu	0.08	-0.20	-2.61	-4.69	-5.06	3.92	-0.02	-0.33	0.00	-5.29
Sikar	5.90	0.86	-0.95	-1.11	-3.83	3.91	-5.35	-0.96	0.02	-2.13
Jaisalmer	-0.97	1.30	-6.94	2.30	0.39	2.46	1.09	0.40	0.00	-4.38
Jalore	0.16	0.41	1.57	2.56	2.24	-6.33	-0.07	-0.51	-0.01	3.73
Jhunjhunu	0.95	1.62	-0.12	0.92	-0.80	-0.19	-1.19	-0.63	0.01	1.79
Jodhpur	0.14	-0.04	1.54	-2.44	3.56	-5.51	-0.75	-0.12	0.00	-0.15
Nagaur	0.13	0.64	0.15	-0.89	-3.38	4.40	0.31	0.01	0.00	-0.43
Banswara	3.23	2.67	1.75	2.46	-1.90	6.46	-6.26	-3.84	0.05	5.98
Chittorgarh	3.09	1.20	-7.25	1.44	0.53	5.78	-5.08	-0.21	-0.06	-7.22
Dungarpur	-6.48	7.33	-2.10	2.58	-0.14	-1.05	-4.70	-2.28	0.34	-2.31
Pali	1.90	3.80	1.37	-2.60	0.06	0.38	-2.94	-0.26	0.00	-3.40
Sirohi	2.81	3.88	-1.97	4.39	1.71	-3.67	-7.42	-0.58	0.01	1.87
Udaipur	-0.15	-0.81	-5.99	4.35	0.25	-1.48	-5.77	-1.19	0.12	-5.66
Ajmer	1.91	3.86	-3.72	0.17	2.09	1.17	-4.69	0.33	0.01	-3.41
Alwar	6.79	2.73	-1.30	-5.33	-4.02	3.41	-8.57	-0.03	-0.05	-6.98
Bharatpur	3.87	0.83	3.00	1.69	1.57	3.65	-4.33	-0.06	0.01	-5.81
Bhilwara	-3.30	-2.86	-3.66	-4.46	15.81	-10.15	-18.04	-4.52	-0.16	-8.33
Bundi	5.34	2.45	-1.41	-5.44	-5.48	4.58	-4.23	0.53	-0.03	-7.87
Dholpur	5.16	-0.71	3.96	-0.50	3.01	3.87	-4.99	-0.85	-0.03	-1.09
Jaipur	2.34	3.66	-3.65	-3.58	-1.47	9.99	-3.33	-0.70	-0.02	-8.17
Kota	-0.34	4.37	-2.46	-1.01	-1.07	1.94	-3.65	-0.76	-0.05	-4.77
S.Madhopur	5.84	3.52	0.12	-0.58	-0.47	-0.27	-7.56	-1.33	-0.01	0.74
Tonk	1.60	2.51	-4.44	0.49	1.88	5.77	0.27	-4.68	0.01	-6.02
Jhalawar	-0.29	-0.05	-3.62	1.61	-0.60	-1.94	-1.71	-0.49	0.05	-1.96
Rajasthan	**1.31**	**1.66**	**-4.56**	**0.63**	**-0.31**	**1.69**	**-1.92**	**-0.45**	**-0.01**	**-5.29**

*Landuse changes have been calculated taking average values of 1979-80 and 1980-81, and similarly 1999-2000 and 2000-2001.

** Positive value indicates increase whereas negative value indicates decrease.

Source: Computed from Land use Data

RAJASTHAN
CHANGE IN EXTENT OF CULTIVABLE WASTELAND 1980-2001



Source: Computed from Land use Data

Although we straight forwardly cannot conclude that this 5.29 percent point decline in underutilized lands have gone under which land uses, but an overview at the other land use changes can give us an idea about the categories which experienced corresponding increase. There have been corresponding increase or decline in all other land uses. Net sown area, non-agricultural uses, and forests (in that order) are the categories that have increased whereas barren and unculturable waste has declined

Rest of the land use categories has remained more or less stagnant. With development process non-agricultural uses are bound to increase but the land for them should come from barren and unculturable waste, or culturable waste. In this sense the scenario here seems favourable but the culturable waste still occupies a large area, which needs to be brought down.

There are significant inter district variations (map 2.VII). The highest decline in culturable waste has been observed in districts of western Rajasthan like Bikaner (22.29 percent), Ganganagar (10 percent) and Jaisalmer (6.94 percent). Bikaner have corresponding increase occurred in net sown area by 8.24 percent (maximum), non agricultural uses increased by 4.22 percent, fallow other than current fallow increased by3.88 percent and current fallow and forests by 2 percent each. Thus we can see that most gain has been by net sown area and non-agricultural uses. Ganganagar district, which have good irrigation infrastructure recorded significant decline (10 percent) in the culturable waste. The corresponding increase has been observed in current fallow, fallow other than current fallow and forests. This shows that the net sown area has not increased. The extension of irrigation facilites and implementation of command area development

The districts, which have recorded increase in culturable waste, are Jalore, Jodhpur, Banswara, Bharatpur, Dholpur and Pali. The highest increase has been observed in Dholpur (3.96 percent) and Bharatpur (3.0 percent). The situation is very serious in Jodhpur and Jalore, which have recorded decline in net sown area by more than five percent each. Bharatpur and Dholpur have recorded increase in net sown area and have significantly reclaimed barren and unculturable waste (more than 4 percent each).

Thus the land use changes reveal that total cultivable wastelands have declined along with barren and unculturable waste, current fallows, permanent pastures have recorded marginal decline whereas land under miscellaneous tree grooves have remained almost constant. The net sown area, forests, and land under non-agricultural uses have witnessed significant increase. The desirable situation is that area under forest should increase to maintain ecosystem services and also the net sown area to improve the economic condition. Barren and unculturable waste should be promoted to be brought under non-agricultural uses like industries, urban space etc, which otherwise would engulf the valuable cultivated land.

2.8. Conclusion

The major findings of the chapter can be summarized as:

There are significant spatial variations in the extent of cultivable wastelands in Rajasthan. There is high proportion of such lands in the western arid agro-climatic zone. There are significant differences between the cultivable wasteland estimates of the MoA and NRSA, which are partly determined by the variables that may affect farmer's perception. The variables that affect farmer's perception are land productivity, average annual rainfall, irrigation and road infrastructure in the area.

The causal processes of cultivable wastelands show shift from west to south and eastwards. There is dominance of wastelands created mainly by natural agents in west arid agro-climatic zone whereas it goes on decreasing eastward, giving place to man-made processes in the eastern plain agro-climatic zone.

During last two decades (1980-2001) the underutilized lands (total cultivable wastelands) have declined significantly in Rajasthan, with major increase recorded in net sown area, non-agricultural uses and forests. The fallow other than current fallow have remained nearly constant thus major decline has been in culturable waste, particularly in districts that have high irrigation infrastructure.

CHAPTER-III

Determinants of Underutilization and Degradation of Land in Rajasthan

3.1. Introduction

Land constitutes most crucial natural resource and serves as base of all other economic activities. The judicious management of this natural resource is needed to maintain the self-sufficiency in food production and ecosystem services. Unscientific uses and management practices could affect the health of natural resources adversely or they may not allow the potential to be used fully. The underutilized and degraded land occupies a significantly high proportion of the geographical area in Rajasthan. These lands offer us hopes of further extension of cultivated area and other uses like pastures, forests etc. They can affect other resources natural resources like forest and water as they are linked to each other. The dynamics of these lands need to be fully understood for making appropriate policy interventions. Thus objectives of this chapter are:

(i) To analyze the determinants of spatial patterns of underutilized and degraded lands.

(ii) To compare the determinants of underutilization and land degradation.

3.2. Underutilized and Degraded lands

Little attention has been paid to the under utilisation of the land resources in our country especially in the drought prone areas of the country (Reddy, 1991). The areas couldn't benefit much from the technological changes that have occurred in Indian agriculture because of the capital-intensive nature of these changes, limited economic resources with the farmer and low productivity levels, which do not make the adoption of this technology conducive. The above-mentioned scenario is applicable to Rajasthan to a greater extent. The Directorate of Economics and Statistics land use classification includes three categories accounting for the under utilised lands – current fallows, fallow other than current fallow and culturable waste. These are differentiated on the basis of the time period for which they have been left unused, current fallow for less than one year, fallow other than current fallow more than one year but less than five years and culturable waste for more than five years. The reasons for not cultivating culturable waste 'includes constraints such as poor soil fertility, problems such as salinity alkalinity and water logging, litigation etc. (Sharma et. al.1990 quoted in Chadha et.al.2004). Similarly fallow other than current fallow are accounted for by 'poverty of the cultivators, inadequate supply of water, silting of canals and rivers and unremunerative nature of farming. These lands are partially degraded' (Chadha, sen et. al. 2004). Thus culturable waste and fallow other than current fallow account for degraded and partially degraded lands. Studies have shown that current fallows in drought prone areas depend mostly upon annual rainfall and they have significantly high annual fluctuations. Thus the extent of current fallows can be attributed to climatic variables like average annual rainfall and rainfall variability. We are not including the current fallow in our analysis as they are highly localized and fluctuate from year to year. In the following section cultural waste and fallow other than current fallow have been included as they are partially degraded lands and are thus out of use because of physical or socio-economic constraints.

3.3. Determinants of Unused and Under-used Agricultural Land

The level of under utilization in a way reflects allocative efficiency along with decision-making process and in turn depends on various economic, climatic and institutional factors (Reddy; 1991).

Climatic factors like **average annual rainfall** and **rainfall variability** indicate the drought proneness of an area. In moisture stress region like Rajasthan higher rainfall would promote better growth of vegetation. It would also reduce the risk of crop failure in agriculture, thus favour agriculture and consequently farmer would tend to bring higher proportion of land under plough even if he have to make additional inputs in terms of labour or economic inputs. There are some processes that cause greater degradation of land quality in low rainfall areas, for example overuse of irrigation in arid areas have lead to the problem of salinity and alkalinity in many parts of the world.

Hence our hypothesis here is that there should be greater degradation of land in arid areas and hence leading to greater unused potential of land. Similarly variability of rainfall from the average annual values would also indicate the risk, which the farmer is prone to, higher variability will not provide incentive for the farmer to make additional economic inputs in terms of economic inputs. Hence it is expected that higher the variability of rainfall higher will be the underutilisation of land i.e. positive relationship is expected between underutilisation of land and annual rainfall variability over the years.

Forest cover: It is known to prevent the soil erosion and also contribute to the humus content of the soil. Thus a negative relationship is expected between proportion of forest cover and unused potential of the land and land degradation. Forest will also reduce the pressure on the agricultural land, as it would provide alternate sources of livelihood to the rural population.

Net sown area is expected to have negative relationship, as it will provide cover to the soil for at least a part of free year. Thus a negative relationship is expected between degradation and proportion of net sown area. Population pressure on land causes more intensive use of the land resources and ultimately put even marginal land under some productive use or the other. It can have adverse effect on the health of the natural resources as over exploitation may lead to deterioration of the resource base especially the common property resources (Jodha, 1985). But in under populated areas population growth should have favourable impact and lead to proper utilisation of the unused potential of the resources. In case of Rajasthan we expect a negative relation i.e. greater population pressure would lead to use of even other wise less productive land under some use.

Land productivity in an area would promote agriculture and thus lower under utilisation of land resources. It also enables the farmer to take corrective measures on his own and makes possible the adoption of technological inputs conducive which otherwise wouldn't have been possible.

Rural Poverty and Resources Degradation: The relationship between the two is very complex and controversial. The most popular explanation offered is through the concept of 'vicious circle' (poverty- environmental degradation- more poverty). The basis for this perception is that in developing or relatively poor countries the poor depend on the natural resources environment for livelihood (Nadkarni, 2000). But fragile resource zones have low productivity of land and thus high potential for poverty but people inhabiting these zones have developed appropriate livelihood strategies and institutions. These institutions if operated successfully can prevent or at least reduce environmental degradation (Jodha, 1998). In such regions poor takes care of their natural resource base more than rich since his livelihood is solely dependent upon that. Further the rich makes greater use of the common property resources of the community like having larger size of herd in pastoral communities etc. Thus our hypothesis is that in the fragile resource zones due to lower productivity level and higher risk there is a strong realization of the links between sustenance and productivity of the natural resource base. The poor takes care of the resource base and develop strategies that cause least damage to the health of natural resources.

Irrigation facilities: Application of irrigation increases the productivity of land many times and it also it reduces the vulnerability to crop failure. The increased productivity will provide incentive to bring more land under cultivation and thus drive the farmer to take reclamation measures at his own to bring marginal and cultivable wasteland under plough. Thus irrigation infrastructure is expected have negative impact on cultivable waste lands, increased irrigation facilities should lead to lowering the area under cultivable waste and the other than current fallow and shortening of follow lands. But over-irrigation may have adverse effect and lead to the problem of water logging and salinity-alkalinity in hot arid and semi-arid areas. Hence our hypothesis here is that irrigation infrastructure should lead to decrease in the cultivable wasteland i.e. they have negative relationship.

Livestock: The relationship between livestock and wasteland is rather controversial; according to one point of view higher livestock density, leads to overgrazing over the rangelands and leads to environmental degradation (Hanumantha Rao, 1994) whereas another view is that it is an adaptative strategy in the fragile zones which have otherwise higher fluctuations in agricultural production and very less of the land under cultivation. Common property resources and wastelands support the comparatively higher livestock density found in the fragile semi-arid and arid zones. A part of the livestock is also used as draught animals and thus enables the agricultural operations; further the livestock provides the much needed farm manure for agriculture. The use of livestock has been found to be less degrading than tractors in agricultural operations (Reddy, 2003).

The average size of operations holdings is expected to have negative relationship with the extent of cultivable wastelands. An already larger operational holding with the farmer leaves much less incentive for bringing additional cultivable wasteland under cultivation. On the other hand a farmer with small operational holding will tend to put maximum possible of the available land under agriculture and thus leave less of fallow and cultivable waste. He will tend to utilize the land to the maximum possible extent.

3.3.1. Specification of Variables

Dependent and Independent variables are measured in the following manner

Dependent Variable

CWLFOCF = Proportion of area under culturable waste and Fallow other than current Fallow to total geographical area.

Independent Variable

(i) Gross Irrigated Area as percentage of gross sown area

(ii) Average size of operational holdings

(iii) Land productivity in Rupees / hectares

(iv) Livestock density (sheep + goat + cattle + Buffalo) adult cattle units /hectare

(v) Land man ratio measured as numbered of rural population per hectare of net sown area

(vi) Rural poverty ratio

(vii) Net sown area as proportion of reported area

(viii) Forest cover as proportion of reported area.

All these variables have been included to find correlation matrix. The variables having significant correlation coefficients have been considered for regression analysis. To overcome the problem of multicollinearty, one of the two variables that have high degree of correlation has been left out. The analysis has been performed for the district level data of various variables.

Table 3.1

Determinants of the Unused Potential of Land: Regression Results

(Culturable Waste and Fallow other than Current Fallow)

Particulars	Dependent Variable: Fallow other than Current Fallow + Culturable Waste
Functional form	Linear
R^2	.838
F- value	34.503
Constant	55.423
Explanatory variables	Regression coefficients
Net sown area	-.716 (-7.462)*
Forest cover	-.525 (-2.831)*
Average size of operational holdings	0.910 (1.416)
Man-land ratio	-1.589 (-1.545)
Rural Poverty	0.158 (.970)

Note (i)* indicates significance at 1 percent level of significance

(ii) Figures in parenthesis are t-values.

The regression results (Table1) show that two variables, net sown area as proportion of the geographical area and forest cover as proportion of geographical area emerge as important determinants explaining the variation of the extent of culturable waste and long term fallow. These two resource variables net sown area and forest cover bear negative relationships with the land underutilization. Thus the hypothesis that net sown area will provide adequate cover for the soil and act as a supply side variable that will lower the pressure on the forest and grazing land is validated. Similarly, forest cover also have negative relationship with the extent of waste and long term fallow as it prevents soil erosion and help provide people with livelihood need like fuel, fodder etc. which otherwise would have been a burden on the net sown area.

Average size of operational holdings represents positive relationships with the extent of culturable waste and long-term fallow, although the relationship is statistically insignificant. The negative sign is indicative of lower level of incentive to reclaim partially or wholly degraded lands as compared to the smaller ones who have no alternate sources of livelihood, as a result they are ready to invest labour in reclaiming and undertaking land development measures. The agricultural operations are performed mostly with animal power and hence, there is little scope to put extra land under plough for the large farmer.

There is a close relationship between land left unused and degradation of land (Chadha, et.al. 2004). The relationship could better be understood if we have analysis of the land degradation.

3.4. Determinants of Land Degradation

Land degradation is the "reduction or the complete loss of natural capacity to produce healthy and nutritious crops resulting from erosional loss of nutrient rich surface soil, leaching of the nutrients, reduced water retention, surface sealing, hard pan formation and accumulation of toxic chemicals etc. The loss of productivity occur inspite of very favourable climatic and other non edaphological factors" (Somasiri, 2004:

pp.68). Degraded land, which add to the stock of culturable land usually result from natural processes accelerated by man-made processes or the man-made activities alone (Chadha, et.al. 2004). They result from indiscriminate utilization of the natural resources, which in turn are affected by economic, demographic and institutional factors. Land degradation is a serious threat to the social, economic and political stability of the country as it threatens the livelihood of the rural community, which depends directly on the land. It is the result of some direct (proximate) factors like inappropriate land uses and farming systems, lack of investment for land improvement, lack of awareness and knowledge about the conservation strategies, overgrazing, poor water management etc. Varying remedial measures are applied and strategies adopted to improve the land quality with the aim of improving land productivity. Nevertheless, these attempts have not given due attention to the underlying causes of land degradation and thus not made a significant dent in eliminating them. These underlying causes that promote activities responsible for land degradation and the failure of the technical measures to eliminate them are ultimately linked to the socio-economic factors like population pressure, inability of government institutions to implement conservation laws, lack of community participation, land distribution and so on. Thus land degradation has to be analyzed in a larger socio-economic context rather than a narrow techno-economic one. The problem of degradation of agro-ecosystems has posed a major challenge before the agricultural planners and policy makers in the post green revolution period. The most comprehensive estimates of the degraded lands are provided by the NRSA 'Wasteland Atlas of India' (2000) prepared for the Department of Land Resources, Ministry of Agriculture. In the following section an attempt has been made to find out the determinants of degraded cultivable wastelands. The variables used are same as has been used in the underutilization of the land in previous section. The purpose here is to identify whether the processes explaining underutilization of land as reported by farmers is similar to that of the bio-physical view of degradation given by remote sensing data.

3.4.1. Dependent Variable

The dependent variable is total cultivable wasteland (DCWL), which has been arrived at by adding the first 10 categories given by NRSA Atlas (see chapter 2)

3.4.2. Independent Variable

(ix) Gross irrigated area as percentage of gross sown area

(x) Average size of operational holdings

(xi) Land productivity in Rupees / hectares

(xii) Livestock density (sheep + goat + cattle + Buffalo)/hectare; measured in adult cattle units (A.C.U.) (Puskur and others, 2004)

(xiii) Land man ratio measured as numbered of rural population per hectare of net sown area

(xiv) Rural poverty ratio

(xv) Net sown area as proportion of reported area

(xvi) Forest cover as proportion of reported area.

The correlation matrix has been obtained first and then highly correlated variables have been excluded to overcome the problem of multicollinearity. Then stepwise regression has been carried out to find out the determinants.

Table 3.2

Factors affecting Land Degradation: Regression Results

Dependent variable	Dcwl
Functional form	Linear
R^2	0.435
F- value	5.997
Constant	43.281
Regression coefficients (t values in brackets)	
Net sown area	-0.613 (-3.848)*
Forest cover	- 0.284(-.764)
Rural poverty	0 .0088 (.280)
Average size op.hldgs.	1.267 (1.215)
Land productivity	0 .00219 (1.657)

Note: * Indicates significance at 1 percent level of significance

The regression results indicate that net sown area as proportion of geographical area is the only significant determinant of the land degradation. It has negative relationship with the land degradation. Thus if there is favourable resource variable then there is not much exploitation of the forest, grazing land etc. The increased pressure of the population is somewhat negated by greater availability of the resources.

3.4.3. Determinants of Components of Degraded Cultivable Lands

Table3.3
Determinants of Different Categories of Degraded Cultivable Wastelands: Regression Results

DependentVariable:	Salinity	Sands	Drg_Past	Gull/Rav	LWOWS	Deg. forest
Functional form	Linear	Linear	Linear	Linear	Linear	Linear
R^2	0.219	0.37	0.147	0 .216	0.674	0.425
F- value	2.82	16.28	2.498	3.381	14.416	7.396
Constant	5.438	-29.53	7.945	-.332	13.212	-8.807
Regression coefficients (t values in brackets)						
Net sown area	NA	NA	NA	NA	-.296(-5.114)*	NA
Forest cover	-.0040(-1.523)	NA	NA	NA	-.562(-3.684)*	NA
Rural poverty	NA	NA	NA	-.108(-1.339)	NA	.122(1.052)
Av. op.hldgs.	-.332(-2.922)*	NA	NA	NA	NA	NA
Land productivity	NA	NA	NA	.00029(.747)	NA	NA
Gross irrigated area	NA	NA	-.126(-2.151)**	NA	NA	.179(2.977)*
Man-land ratio	-.422(-2.403)* *	NA	-.850(-2.301)**	NA	1.578(3.088)*	NA
Rainfall variability	NA	.801(4.035)*	NA	NA	NA	NA
Rainfall	NA	NA	.0565(1.321)	NA	.173(2.674)*	.106(2.483)**

Note: (i) *and **indicate significance at 1and 5 percent level, respectively

(ii) NA – not significantly explaining hence they have been left out.

The analysis of the determinants of degraded cultivable land as a whole may not capture the actual processes operating behind land degradation fully. Land degradation is a localized phenomenon and thus different forms of degradation must be looked at individually. In this section an attempt has been made to analyze the determinants of various components of degraded land. Regression analysis has been performed at the district level. Individual categories of degraded lands have been regressed as dependent variables against independent variable of resource/physical variables like net sown area, forest cover, average annual rainfall and rainfall variability. Economic variables like rural poverty, land productivity and average size of operational holdings, demographic variable man land ratio and gross irrigated area as percentage of gross cropped area as infrastructure development variable.

Land under water logging has been excluding from the regression analysis because of very limited area under this category and that too within five districts. Water logging is a problem persistent in the canal command area because of unscientific and irrational irrigation practices. This is prevalent in the Chambal command area-Kota district, IGNP canal command area- Ganganagar, Bikaner and Hanumangarh districts, and some area in Bharatpur district, which is irrigated by branches of Yamuna canals. The problem of water logging is largely because of sub surface geological formations, which are rich in calcium carbonate. These formations lead to formation of hard pan after excessive irrigation and thus prevent percolation of water downwards (Jyotsna, 2003). This water in the root zone of the plants inhibits their growth and subsequently the land goes out of any economic us. The regression results show that climatic variables like rainfall and rainfall variability although doesn't exhibit direct relationship with total degraded cultivable wastelands but they have significant relationship with some categories like desertic sands. Desertic sands are the result of very low rainfall, which in turn lead to poor vegetation cover and poor development of the soils. The scant rainfall is highly erratic also. Man-land ratio, which was excluded in the final analysis of the determinants of total degraded cultivable wastelands because of significantly high correlation with the average size of operational holdings, affects directly the extent of land with or without scrubs. High population pressure leads to the removal of the vegetal cover and making it vulnerable to wind and water erosion, which leads to land with or without scrubs. The positive relationship with average annual rainfall confirms this. This is a major category of degraded land in the state. The negative relationship of land with or without scrub with net sown area and forest cover shows that favourable resource variable would prevent degradation. Degraded notified forest areas are positively associated with irrigated area and average annual rainfall. Increased irrigation facilities add extra pressure on the forests for grazing, demand for fuel wood etc. The resultant overexploitation leads to the degradation of the health of the forests. The degradation being positively associated with annual rainfall shows that notified forests do not degrade because of natural or climatic factors only. Salinity and alkalinity occurs under natural conditions in arid regions as it is part of the natural soil process (particularly in the depression surrounded by uplands) that by capillary action salts from the sub soil zone tend to get transferred to the top soil, the irrigation and salinity doesn't have any concurrence in our case. Salinity is also confined to areas that have low pressure of the population on land i.e. they are negatively related to man-land ratio. Salinity is also found to be less occurring on farm of large farmers as they have economic resources at their disposal to treat them.

3.5. Comparison of Determinants of Underutilization of Land and Land Degradation

The analysis shows that underutilization of land and land degradation are both determined by the resource variable net sown area. Underutilisation is also determined by forest cover. The higher availability of these resource variables prevent the land degradation processes and ultimately leading to low under utilization.

3.6. Conclusion

The major findings of the chapter can be summarized as:

The processes of land degradation and under utilization in Rajasthan are almost same. Land degradation is a localized phenomenon therefore there is need to focus on specific processes that operate in any area. The determinants of different categories of degraded lands show that each process is a localized phenomenon. The results show that climatic variables like rainfall and rainfall variability although doesn't exhibit direct relationship with total degraded cultivable wastelands but they have significant relationship with some categories like desertic sands. Desertic sands are the result of very low rainfall, which in turn lead to poor vegetation cover and poor development of the soils. Similarly man-land ratio, affects directly the extent of land with or without scrubs as high population pressure leads to the removal of the vegetal cover and making it vulnerable to wind and water erosion, which leads to land with or without scrubs. These are not caused by lack of rainfall i.e. dry and arid conditions. There is need to work with primary data and incorporate farmer's perspective because they live off the land and hence their involvement is important for the success of reclamation.

CHAPTER-IV

Policies and Programmes for Land Management in Rajasthan

4.1. Introduction

Land is a vital natural resource in any country. It is essential base for production of basic needs-food, fibre and fuel for people. Its preservation is of paramount importance for the protection of the environment stability and ensuring that needs of the current and future generations will be adequately met. Further it is a limited resource base, once degraded it loses its natural capacity to support life. Unlike in the industrial countries, agricultural sector in the developing countries contributes the largest share of GNP. In these countries majority of the country's labour force is employed in agricultural sector. India fits well into the above mentioned context. The increasing demand for food grains and other agricultural products due to high growth rates of population have posed great challenges for the policy makers and planners. Therefore various strategies have been adopted from the beginning of planning process in the country to ensure self reliance in agricultural production. The pressure on the land is often beyond its carrying capacity, leading to various process of land degradation and turning farmlands into wastelands. Planning for the management of natural resources in agriculture is central to the national planning in India since the beginning of the planned development of economy. Various programmes have been started to achieve the desired goals. States formulate their own policies keeping in view the resources at their disposal and priorities for them depending on the local conditions. Rajasthan is also not lacking behind in that direction, it has also laid significantly higher priority to agriculture and irrigation development in all its five-year plans. Thus there is rationale for studying approaches and policies related to land resources management in particular and agricultural development broadly. The objectives of this chapter are as follows:

1. To compare the approaches and strategies of land resources management adopted in various five-year plans of state and national plans.

2. To compare the need based priorities of fund allocation among various districts with the priorities that emerge from the existing pattern of spatial distribution of funds under various programmes.

4.2. Comparision of Land Development Policies at National and State level

Table 4.1

Land Management Policies in National Five-Year Plans

First phase 1st and 2nd plans	**Second phase** 3rd to 5th plans	**Third phase** 6th plan onwards
Expanding cultivable land frontier	Shifting to intensive land management practices.	Policies oriented to dry land and rain fed agriculture
Strengthening regulatory framework	Resource concentration in developed areas	Pointed focus on disadvantaged groups.
Enhancing panchayat participation	Restricting conservation efforts to canal commands	Beginning of peoples participation

Source: Sen, 2004

Table 4.2

Land Management Policies in State Five-Year Plans

First phase 1st & 2nd five year-plans	**Second phase** 3rd- 5th five year plans	**Third phase** Sixth plan onwards.
Extension of net sown area	Intensive land use in best potential area through higher input use	Extending suitable dry forming techniques for land areas.
Emphasis on fair and equitable distribution of land resources.	Soil conservation and land reclamation measures promoted by forest and agriculture department.	Efficient utilization of natural resources like water, land got emphasis
Land improvement through reclamation of wastelands in irrigated area got attention marginally.	Efforts for optimum utilization of the benefits from irrigation project– CADP.	Agricultural diversification emphasized-horticulture, livestock, agro processing etc.
Democratic decentralization	By the end of this phase it was realized that the scope for expanding the cultivated area is limited, attention towards alternatives.	Environmental issues got prominence, decentralised planning for natural resources management (NRM).

Source: Compiled from various state five year-plans

A survey of the five year plans of the state and central government thus brings to light that approaches and strategies for land management policies in the state five year plans are broadly in consonance with the national plans. The focus in national plans have shifted from expanding cultivated area in first- and second five year plans to intensive land use practices in the third to fifth five year plans. From sixth plan onwards the emphasis has shifted to agricultural diversification. The limited scope for further expansion of the cultivated area in the state was recognized by the fifth five year plan and there after increasing emphasis has been given towards development of alternatives like dairy industry, horticulture and agricultural diversification towards high value crops. Although the state plans recognized the need for land improvement and land reclamation in irrigated areas in 2nd five-year plan but it got emphasized from third plan onwards. Environmental issues got greater attention from sixth plan onwards as a result various programmes were started for the eco system development of The Aravallis, The Thar region and The Vindhyas.

4.3. Land Management Programmes in Rajasthan

Most of the area of the state falls under arid and semi-arid climatic conditions. Twelve districts, covering 61 percent of the geographical area of the state, constitute a part of the Indian desert region. The region is the world's most crowded desert, the population density varies from 30 to 77 persons per square kilometre depending upon places, occasionally going down to 13 in some districts. The major characteristics of this hostile and dry region are severe wind erosion, high temperature, scanty and erratic rainfall, frequent droughts, high rate of evapotranspiration, sparse natural vegetation cover etc. The soils of the arid zone are mostly sandy to sandy loan consisting of excessive permeability and these are generally suffering from lack of moisture, nutrients and micro organisms which limit the crop production and plant growth. The increased biotic pressure, high incidence of poverty in rural areas, faulty land use practices, over exploitation of the natural resources and breakdown of traditional institutions for managing common property resources and failure of new institutions to fill the vacuum have lead to the problem of the degradation of the environment, resulting into soil erosion and land degradation, lower productivity of natural resources, depletion of natural resource like ground water leading to shortage of drinking water for man and animal. The irrigation infrastructure in the state is also not adequate (less than one third of the net sown area is irrigated). All these factors constrain the agricultural growth in the state, thus soil and moisture conservation has great importance for this region. With time a shift has occurred shift from sectoral approach of resource conservation to system based approach of management of watershed. The land development programmes as a result now focus on integrated development with an emphasis on enhancement of rural livelihood status attempted through natural resource management with watershed as the unit of operation. In recent year the participation of the non-governmental organizations and beneficiaries in making the programmes sustainable has been incorporated (Chadha, et.al.2004).

Two types of programmes, land development programmes concerned with underutilized lands and land reclamation programmes dealing with reclamation of degraded lands have been in operation since last few decades. These programmes can be subdivided on the basis of the implementing agency into three categories, programmes implemented by Ministry of Rural Development (MoRD), Ministry of Agriculture (MoA) and Department of Forests (DoF). The ministry of agriculture programmes focus on private lands whereas department of forests concentrate on government and community land resources. Most of these programmes are centrally sponsored with some being run by the state government with assistance from external funding agency like World Bank. The following section provides a brief survey of land development and land reclamation programmes, which have been implementation in the state.

4.4. Programmes Implemented by Ministry of Rural Development

4.4.1. Drought Prone Area Programme (DPAP): It was launched in 1973-74 to tackle the special problems faced by those areas constantly affected by severe drought conditions. The programme has been under implementation on watershed basis since 1st April 1995, based on the recommendations of the Hanumantha Rao Committee (1994). The responsibility for planning, executing and maintaining the watershed projects is entrusted to local people's organization specially constituted for the purpose. However, for the projects sanctioned under Hariyali guidelines with effect from 1st April, 2003 the panchayati Raj institutions have been given pivotal role. The Hanumantha Rao committee made the identification of DPAP blocks in 1994-95 adopting scientific criterion based on Moisture Index, Rainfall and Evapo-transpiration. DPAP covers 32 blocks in 11 districts – Ajmer, Banswara, Baran, Bharatpur, Dungarpur, Jhalawar, Karauli, Kota, Sawai Madhopur, Tonk and Udaipur. The funds are shared by centre and state in the ratio 75: 25.

4.4.2 Desert Development Programme (DDP): It was started on the recommendations of the National Commission on Agriculture in its interim Report (1974) and the final report (1976) in 1977-78. The objectives of the programme are:

1. To mitigate the adverse effects of desertification and adverse climatic conditions on crops, human and livestock population and combating desertification.

2. To restore ecological balance by harnessing, conserving and developing natural resources i.e. land, water, vegetative cover and raising land productivity.

3. To implement developmental works through the watershed approach for land development, water resource development and afforestation/pasture development.

DDP covers 85 blocks covering 198,744 square kilometres (sq. kms)spread over 16 districts – Ajmer, Barmer, Bikaner, Churu, Hanumangarh, Jaipur, Jalore, Jaisalmer, Jodhpur, JhunJhunu, Nagore, Pali, Rajasmand, Sirohi, Sikar and Udaipur.

4.4.3. Integrated Wasteland Development Progamme (IWDP): It was started in 1989-90 as cent percent centrally sponsored scheme. The development of non-forest wastelands is taken up under this scheme. This scheme also aims at rural employment besides enhancing the contents of people's participation in the wasteland development programmes at all stages, which is ensured by providing modalities for equitable and sustainable sharing of benefits and usufructs arising from such projects. The scheme is being implemented on the basis of new guidelines for watershed development from 1st April, 1995. The new guidelines envisage bottom up approach whereby the user's group themselves decide their work programme. The funding pattern of the scheme has been revised from 100 percent assistance to sharing in the ratio of 11:1 between the central and state governments. The scheme covers all the non-DDP/DPAP blocks of the state.

4.4.4. Technology Development Extension Project (TDEP): It is a central sector scheme launched in 1993-94 to develop suitable technologies for the reclamation of wastelands for sustained production of food, fuelwood, fodder etc. This scheme is expected to bridge the gap between the existing technologies and the need relevant to the latest situation. It is implemented through ICAR, state agricultural universities, DRDA and government institutions having adequate institutional and organizational back up. Presently eleven pilot projects are under implementation in various parts of the state.

4.5. Schemes Implemented by Ministry of Agriculture (MoA)

Land improvement was undertaken in the second five-year plan of the state. It was implemented as reclamation of culturable waste, by providing loans to farmers or as subsidy especially in the irrigation project area and soil conservation works in form of bunding, terracing on cultivated land and research on local problems connected with soil conservation. These schemes were undertaken in Pali, Nagore, Jaipur, Bundi, Dungarpur, and Banswara districts. Ministry of Agriculture and forest department, continued soil conservation programmes during third five-year plan in the form of reclamation of saline and alkaline soils and construction of percolation tanks. In the sixth five year plan (1980-85) two new schemes were started by the state government, Reclamation of Alkaline/Saline soils using Gypsum and soil survey of wastelands/soil salinity in irrigation projects with the USAID assistance.

4.5.1. National Watershed Development Programme for Rain fed Areas (NWDPRA) was launched in 1990-91 based on the experiences of pilot projects for water conservation and harvesting in rain fed areas in 19 watersheds. The scheme focuses on an integrated development of natural and social resources, production enhancement opportunities for land owners and provision of livelihood support for the landless. NWDPRA was restructured during the ninth plan. This is a centrally sponsored scheme and covers 201 blocks spread over all districts except Ganganagar.

4.5.2. Ravine Reclamation Programme: It is centrally sponsored programme. It was launched in 1987-88 to reclaim the ravines of the rivers and '*beehads*' and to check the ravines not to spread to fertile areas of the nearby places. This will enable people of the area to have more area under plough. This programme is being implemented in Kota, Bundi, Sawai Madhopur, Bharatpur and Dholpur districts.

4.5.3. Integrated watershed development project (World Bank assisted): It was started in the eighth five year plan (1992-97) in four selected districts Ajmer, Bhilwara, Jodhpur, and Udaipur. Under this programme blocks having more than 30 percent irrigated area i.e. not covered under NWDPRA, but need soil conservation measures were covered. This is a state programme.

4.6. Programmes implemented by forest department

Forest department takes up measures to improve the environment of the region; some are in form of soil conservation in desert areas, fixation of sand dunes, shelter belts along roads, soil conservation in hilly areas, soil conservation in ravines etc. These are undertaken under following programmes:

1. Aravalli Afforestation Project (OECF assistance).
2. Forestry Development Project (EAP).
3. Soil and Moisture Conservation Programme.
4. Pasture Development Programme

4.7. Comparison of Government Priorities for Fund Allocation and the Need Based Requirements of Districts.

The above-mentioned programmes bring a very broad picture of the efforts by government (both state and central) to improve the health and availability of natural resources in agriculture. In the process various regions have got varying degree of attention. This section makes an attempt to find out whether the existing fund allocation pattern in various land development programmes is prioritizing districts based on their ecological and economic needs. The fund allocation priorities in watershed development and soil conservation have been assessed against the ecological fragility of the districts (Sen and Bannerjee, 2004). The Ministry of Agriculture and Forest Department implements the watershed development and soil conservation measures. This programme has been selected because it covers almost all the districts of the state. Other programmes like DDP, DPAP, and IWDP have distinctly defined districts, which are exclusive of each other. The expenditure data have been obtained from annual progress reports of 7th and 9th five-year plans. The expenditure per hectare has been roughly estimated using total geographical area of the districts because of the paucity of data on actual coverage area under these projects. **The ecological fragility** of an area can give us an idea about the requirements of the land development programmes for that area. The resource base, demographic and economic conditions, in turn determines the ecological fragility. An area with favourable resource base and better economic condition of people will put less of stress on the environment. People in less developed societies directly depend upon the natural resources. Any failure of the regulatory institutional mechanism may affect the health of the ecosystem adversely. Thus ecological fragility may form a criterion for fund allocation among various constituent units of a larger region with differing ecological conditions. Resource based, standard of living indicators and demographic indicators may determine fragility of an ecosystem. The specific variables are.

1. Average annual rainfall
2. Cultivable wastelands as percentage of geographical area.
3. Net sown area as percentage of reported area.
4. Land productivity.
5. Rural poverty

The relationships between health of ecosystem (requirement for watershed development and soil conservation measures) and these variables can be summarized as.

Average Annual Rainfall promotes luxuriant growth of vegetation and also favour good agricultural production in a moisture deficient environment like Rajasthan. Only in steep barren slopes it may lead to enhanced soil erosion. Scarcity of rainfall causes failure of crops, shortage of drinking water, degradation of the pastures. Thus rainfall deficit regions need more of watershed development programmes. The lack of vegetation cover ultimately promotes soil erosion. Thus, there is indirect relationship between rainfall and need for watershed development and soil conservation measures.

Extent of Cultivable wastelands in a way represents the state of environment in an area. Higher proportion of area under wastelands is a cause of great concern, as it will affect the availability of ground water also. Further, they may represent faulty or inappropriate land use practices, which might have accelerated land degradation processes. Thus, an already higher extent of wastelands requires urgent attention for stabilizing the environmental sustainability. Ten categories out of the thirteen categories of wastelands (according to NRSA) have been added together to obtain extent of cultivable wastelands (see chapter 2).

Proportion of net sown area: Land development programmes tend to increase the net sown area. Land development and reclamation measures undertake engineering structures to enhance the sustainable productivity of net sown area and prevent degradation of land. Hence watershed interventions are desirable to enhance the net sown area. Since, the percentage of net sown area is lower in Rajasthan compared to other states of India, bringing additional area under plough through land development programmes is extremely important.

Land productivity reflects the economic condition of people directly. A higher productivity often reflecting better quality of land will ensure better standard of living whereas low productivity increases the misery of the peasants. Thus land development measures are needed the most in such areas to enhance productivity. Land productivity has been taken in rupees per hectare.

Rural poverty reflects inability of the farmer to undertake land development and land reclamation measures at his or her own, especially when investment involves substantial economic resources. Therefore, a greater need for land development programmes funded by government is felt.

Using all these variables a composite index has been prepared by using principal component analysis technique of data reduction. First of all the data have been made to have relationship in same direction. Rural poverty and extent of cultivable wastelands have direct relationship with the need for land development programmes. Whereas remaining variables have negative relationship with requirement for land development programmes. Hence these two variables are adjusted as rural population above poverty line and extent of lands other than cultivable wastelands. A regionalization scheme has been generated using spatial variation of these resource and economic variables. Two components have been included to explain greater degree of variation. The first component explains 37 percent of the variation only whereas they together explain 70 percent of the variation.

Table 4.3

Component Score Coefficient Matrix

	Component	
	1	2
NONWASTE	.408	.159
RAINFALL	-.202	.508
APL	.314	.094
PRODUCTI	-.120	.536
NSA	.462	.157

Extraction Method: Principal Component Analysis.

Component Scores.

Note: NONWASTE: 100- proportion of area under cultivable wastelands.

RAINFALL: Average annual rainfall

APL: 100-rural poverty ratio.

PRODUCTI: Productivity in rupees per hectare. NSA: Net sown area

Table 4.4

Deviations of Rankings based on Priority in Fund Allocation from Fragility Index Rankings (Composite Index) during Seventh and Nineth Five Year Plan for Rajasthan

District	Composite index	rank	allocation ranks 7th plan	dev.7th plan*	allocation priority ranks 9th plan	dev. 9 th plan*
Jaisalmer	-4.729	1	26	-25	4	-3
Barmer	-1.735	2	25	-23	20	-18
Dungarpur	-1.625	3	12	-9	2	1
Udaipur	-1.395	4	21	-17	9	-5
Jodhpur	-1.167	5	9	-4	7	-2
Sirohi	-0.887	6	14	-8	25	-19
Bikaner	-0.646	7	24	-17	3	4
Ajmer	-0.586	8	11	-3	5	3
Jhalawar	-0.447	9	10	-1	6	3
Pali	-0.259	10	15	-5	10	0
Banswara	0.008	11	22	-11	1	10
Bhilwara	0.126	12	18	-6	24	-12
Bundi	0.152	13	17	-4	22	-9
Jalore	0.216	14	19	-5	19	-5
Kota	0.243	15	7	8	11	4
Chittorgarh	0.379	16	16	0	21	-5
Dholpur	0.404	17	1	16	8	9
Churu	0.454	18	23	-5	27	-9
Sikar	0.533	19	6	13	13	6
Jhunjhunu	0.562	20	8	12	18	2
Nagaur	0.623	21	20	1	14	7
Jaipur	1.056	22	2	20	17	5
Tonk	1.428	23	13	10	16	7
Ganganagar	1.432	24	27	-3	15	9
S. Madhopur	1.578	25	3	22	12	13
Alwar	1.722	26	5	21	23	3
Bharatpur	2.560	27	4	23	26	1

Note: * Deviation obtained by subtraction of allocation based ranking from need based ranking.

The component score coefficient matrix reveals that first component is affected more by extent of wastelands, net sown area and rural poverty. Second component is affected more by average annual rainfall and land productivity. Based on the index values of factor 1 and factor 2, composite index have been calculated for all the 27 districts of Rajasthan. The districts are ranked on the basis of ascending order of the composite index. A higher value of composite index shows that the district has less of ecological fragility. Jaisalmer have lowest value of the composite index thus shows highest ecological fragility and thus it is ranked as one. Similarly the highest value of composite index is for Bharatpur and it is accorded the lowest rank, 27 i.e. the ecological fragility here is least and thus the district needs least watershed development and soil conservation measures. The districts have been categorized into three groups based on the need of watershed development and soil conservation measures (Table 4.4).

The expenditure incurred per hectare of geographical area of the district may provide us a rough estimate of the qualitative nature of watershed works. In this section districts, which have area coverage under watershed development and soil conservation programmes run by agriculture department and forest department have been taken into account. The agriculture department focus on providing financial assistance to individual farmers for promoting soil and moisture conservation on privately owned lands whereas forest department concentrate on community lands (pastures, forest etc.) and forest areas under the department. The spatial funding pattern of watershed development and soil conservation programmes run by agriculture department and forest department have been ranked depending upon expenditure incurred per hectare of geographical area. The districts are ranked in descending order of expenditure per hectare of geographical area.

This has been done for expenditures incurred in 7th and 9th five year plans. Then deviations of these ranks from the ecological fragility index have been determined (Table 4.5 and Table 4.6).

Table 4.5

Deviations of the Actual Funding Priorities from Priority Based on Ecological Fragility (Seventh Five Year Plan of the State)

Deviations	Districts	Remarks
High Negative	Jaisalmer, Barmer, Udaipur, Bikaner	Actual expenditure priority much lower than deserved according to fragility.
Moderate Negative	Bhilwara, Churu, Bundi, Ajmer, Jalore, Jodhpur, Ganganagar, Jhalawar, Pali, Dungarpur, Sirohi, Banswara	Allocation priority moderately lower than it deserve based on need based index
Zero	Chittorgarh	Allocation priority and need based priority same.
Moderate Positive	Kota, Nagore, Jhunjhunu, Tonk	Moderately higher priority given than they deserved based on need based index
High Positive	Sawai Madhopur, Alwar, Jaipur, Bharatpur, Dholpur, Sikar	Very high priority in allocation as compared to priority according to need

Source: Seventh Five year plan: Rajasthan, Districtwise Expenditures and Physical Achievements, Government of Rajasthan, Planning (gr.III) Department , Secretariat, Jaipur

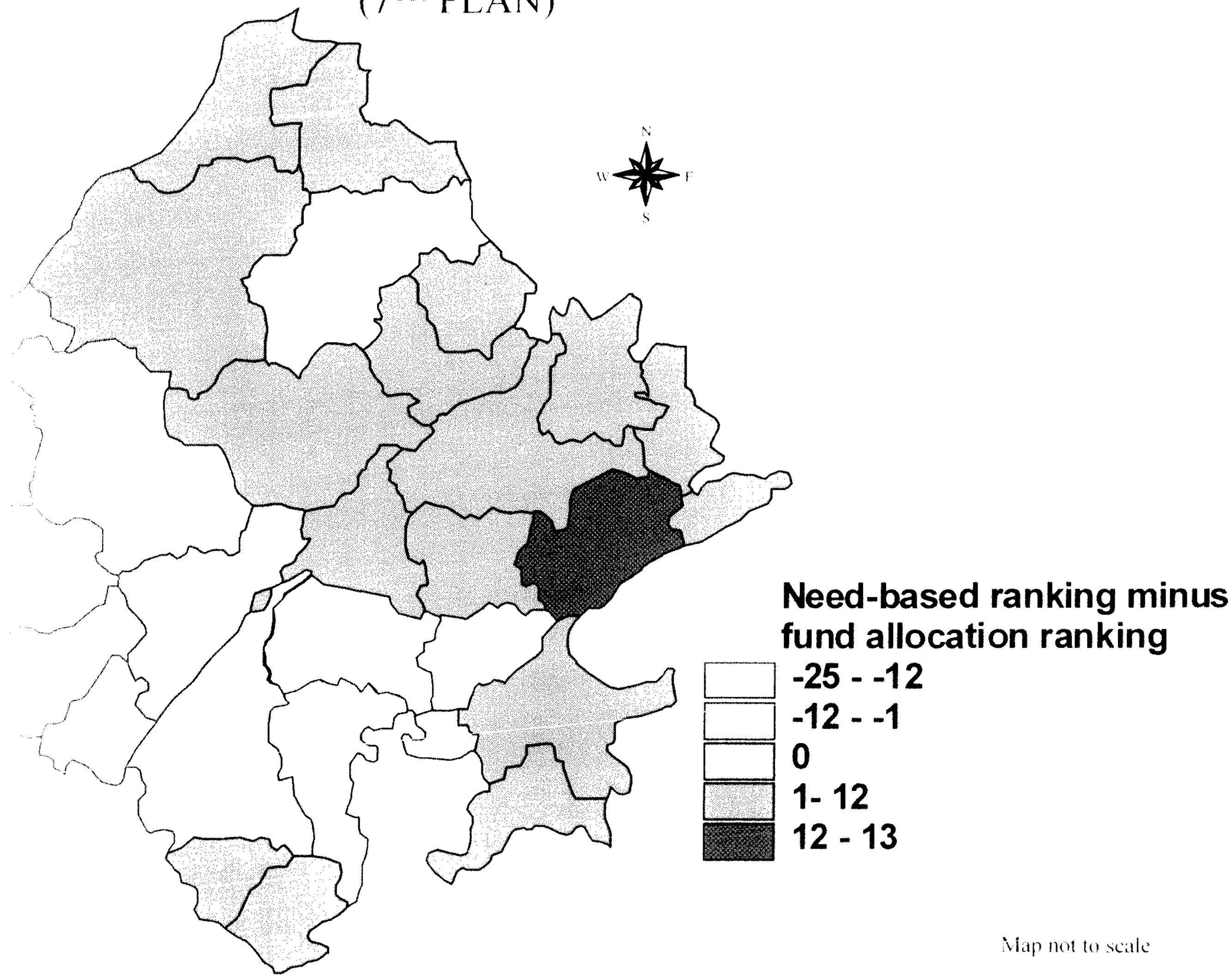
The comparison of the ranks of expenditure incurred per hectare from the ranking based on the requirement of land development programmes for seventh plan (table 4.5) shows that there are significant deviations. Four districts got very low priority (high negative

MAP 4.1

RAJASTHAN

DEVIATION IN FUND ALLOCATION AND NEEDS

(7TH PLAN)



deviations) in fund allocation than they deserved according to their ranking in the ecological fragility and economic conditions, on the other hand six districts got very high priority than they deserved (high positive deviations). The spatial pattern of fund allocation shows greater attention towards eastern and northeastern parts of the state during seventh plan whereas need based requirement was greater in western and south western parts of the state (map 4.I). In this way ten districts got either very low or very high attention than that of their actual needs based on ecological fragility and economic situation in the seventh five-year plan

Table 4.6

Deviations between Actual Priorities of Fund Allocation and According to Ecological Fragility during Ninth Five Year Plan

Deviation	Districts	Remarks
High Negative	Sirohi, Barmer	Actual expenditure priority much lower than deserved according to fragility.
Moderate negative	Churu, Bundi, Bhilwara, Bharatpur, Chittorgarh, Jaisalmer, Jalore, Jodhpur, Udaipur	Allocation priority moderately lower than it deserve based on need based index.
Zero	Pali	Allocation priority and need based priority same.
Moderate positive	Banswara, Dholpur, Ganganagar, Nagaur, Sikar, Tonk, Ajmer, Alwar, Bikaner, Dungarpur, Jaipur, Jhalawar, Jhunjhunu, Kota	Moderately higher priority given than they deserved based on need based index
High positive	Sawai Madhopur	Very high priority in allocation as compared to priority according to need

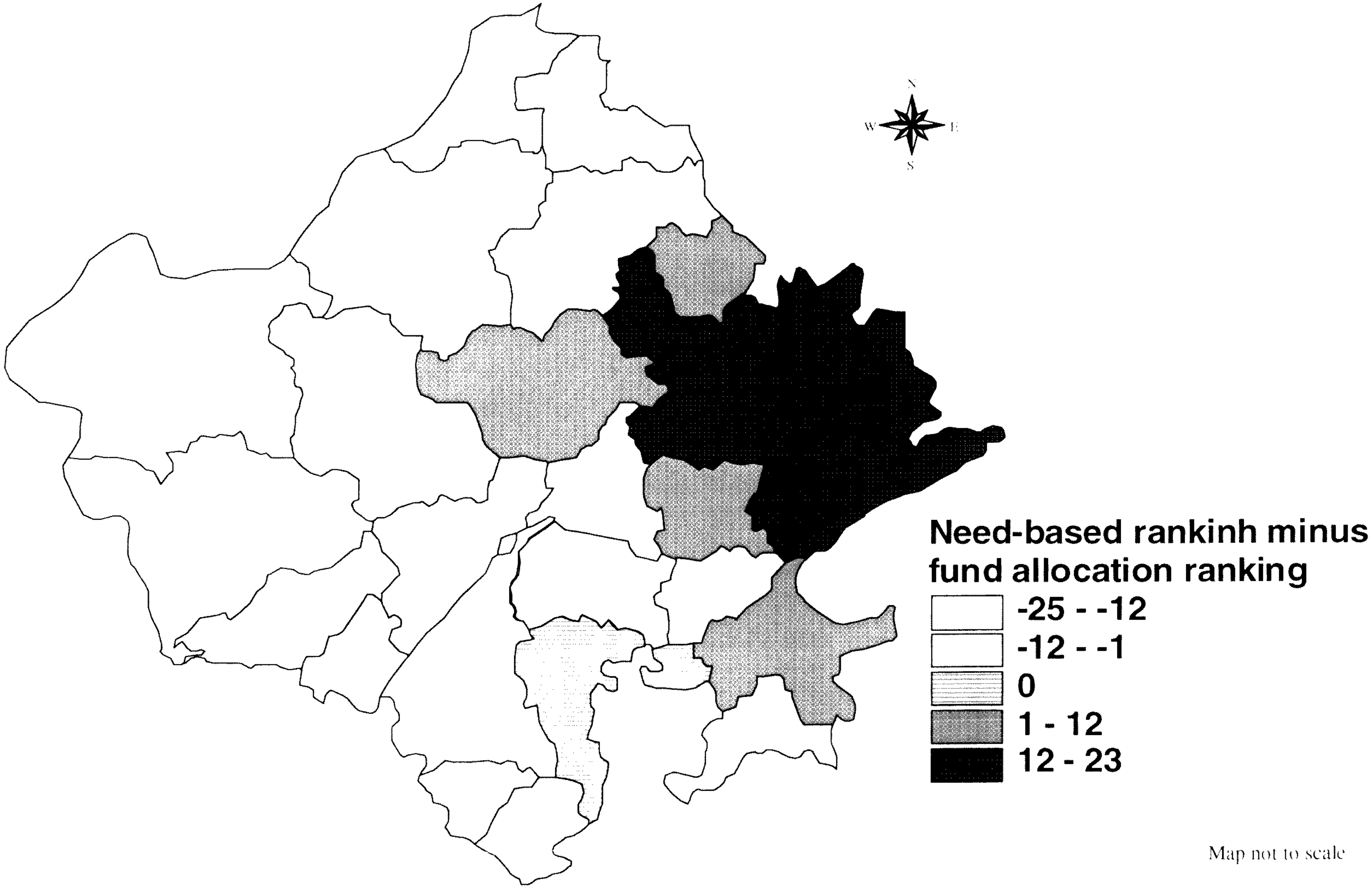
Source: Nineth Five year(1997-2002 plan: Rajasthan, Districtwise Expenditures and Physical Achievements, Government of Rajasthan, Planning (gr.III) Department , Secretariat, Jaipur

MAP 4.11

RAJASTHAN

DEVIATION IN FUND ALLOCATION AND NEEDS

(9^{TH} PLAN)



Similar deviations for the nineth plan (Table 4.6) shows that two districts got very low priority (high negative deviations) in fund allocation than their deserved priority according to the need based ranking whereas only one district is at the other extreme which got very high priority than its need (high positive deviations) (map 4.II). Thus in all three districts got either very low priority or very high priority than they deserved in the nineth plan. This shows that allocations in nineth plan were more according to the need-based priority than in the seventh plan.

The districts that got moderately low priority than they should get according to their ecological fragility and economic standards were twelve in number. The same category had only nine districts in nineth plan. Similarly the number of districts, which got moderately high priority than their priority based on need, also increased from four in seventh plan to fourteen in ninth plan. In both the plans there was only one district, which had allocation priority same as that of priority based on need. Bharatpur, Alwar, and Sawai Madhopur got very high priority in fund allocation in seventh plan than they had based on the need based index. Sawai madhopur enjoyed high priority even during nineth plan whereas Alwar recorded moderately high priority than based on the need and Bharatpur got fund allocation almost according to its need based priority. On the other hand, the districts that got very low priority in fund allocation than their need in seventh plan were Jaisalmer, Barmer, Bikaner and Udaipur. Their position in the nineth plan shows that Barmer still remained in almost same condition i.e. very low priority in fund allocation than its need-based priority. Bikaner improved marginally and got moderately low priority in fund allocation than its need based priority. Jaisalmer and Udaipur got higher priority during ninth plan; as a result they had very low deviations between their actual fund allocation priorities and need based priority.

The Karl Pearson correlation coefficient between composite index values of ecological fragility and actual expenditure incurred per hectare of area reveals that there is no significant relationship between the two for seventh five year plan (the correlation coefficient r = .263). The comparatively low deviation of the ranks of expenditure incurred per hectare to the need based ranking for ninth plan reveal that the fund allocation have been more according to the requirements of the districts. Thus we can say there has been shift in the priorities of fund allocation towards the actual requirement based on resource base and economic condition of people. This shows rational distribution of funds than the earlier plan (seventh). This preposition is further strengthened by the significant negative relationship between composite index of ecological fragility and economic condition and expenditure per hectare during the nineth five-year plan. Here it may be recalled that a higher value of the composite index shows less fragility hence the negative correlation coefficient (r = -.431 significant at 5 percent level of significance) between composite index of ecological fragility and expenditure per hectare actually shows that higher fragile districts have got higher expenditure per hectare. This is a desirable situation. Thus above analysis shows that there has been a shift in the fund allocation priorities of agriculture department and forest department operated watershed development and soil conservation measures. Thus more fund allocation is in convergence with the need of the various districts according to their resource base and economic condition of people.

Table 4.7

Comparison of the Ecological and Economic Need based Priority and Actual Priorities of Government as reflected in the State 9th Five year plan.

	Ecological Fragility Class	High	Moderate	Low
Expenditure class High	Jaisalmer, Dungarpur,Udaipur, Jodhpur, Bikaner, Ajmer, Jhalawar, Pali.			
Moderate			Banswara, Jalore, Kota, Dholpur, Churu, Sikar, Jhunjhunu, Nagore.	Jaipur, Tonk, Ganganagar, Sawai Madhopur.
Low	Barmer, Sirohi.		Bhilwara, Bundi, Chittaurgarh.	Alwar, Bharatpur.

Source: Computed from appendix

4.8. Financial performance

But there is a great concern over the financial performance of districts in terms of actual expenditure as percentage of plan outlay for the year 1999-2000 reveals a very poor performance of the state as a whole. Only 90 percent of the plan outlay was actually spent in the case of watershed development and soil conservation undertaken by agriculture department and similarly the situation was much worse in case of similar works undertaken by forest department (less than 60 percent)

Table 4.8

Financial Performance of Watershed Development and Soil Conservation Measures in Rajasthan 1999-2000. (Expenditure as percentage of plan outlay)

District	Agriculture deptt	District	Forest deptt
Banswara	117.68	Jaipur	190.50
Sikar	112.07	Ajmer	138.62
Barmer	107.98	Dholpur	111.06
Jodhpur	104.13	Dausa	96.67
Nagaur	104.09	Sikar	91.89
Bikaner	101.94	Chittorgarh	78.50
hanumangarh	98.96	karauli	78.00
S. Madhopur	97.71	Tonk	75.86
Ajmer	94.66	Dungarpur	68.57
Jaisalmer	94.17	Rajsmand	65.00
Pali	92.84	Banswara	59.06
Udaipur	91.74	S.Madhopur	55.56
Dungarpur	89.98	Kota	37.12
Jalore	76.77	Bundi	35.00
Jhalawar	73.32	Undistributed	31.00
Kota	57.03	Rajasthan	59.73
Tonk	43.64		
Jaipur	6.83		
Rajasthan	90.46		

Source: Annual Plan 1999-2000, plan outlay and physical target, Districtwise Expenditures and Physical Achievements 1999-2000, Government of Rajasthan, Planning (gr.III) Department , Secretariat, Jaipur

4.8. Conclusion

Thus the major findings of this chapter can be summarized as

The land development policies of the state five-year plans and national five-year planes are broadly similar with a greater emphasis on environmental aspects in agriculture being recognized much earlier in the state five-year plans compared with the national plan.

The land development priogrammes are implemented by three main agencies in the state, Ministry of Agriculture, Ministry of Environment and Forests and Ministry of Rural Development at the national level and corresponding ministries at the state level. Since land development measures are undertaken by three different agencies there is need there ensure proper coordination between them as the village ecosystem is close knit unit or else to look for one department to implement the land development measures.

The requirement of a particular region and expenditure allocation was compared it was observed that there was a substantial discrepancy between these two variable. However, over time this situation has improved whereby there is greater correlation between the requirement and expenditure of various districts. Since the allocation of resources below the state level is the responsibility of the state government, our results indicate that the role of state government in this regard has been positive, But the financial performance of at the state level district as well as is poor and need to improve to ensure proper utilization of funds.

CHAPTER-V

Conclusion

5.1. Introduction

There has been tremendous pressure on land resources in India due to phenomenal increase in population during the last few decades. Along with human population, livestock population has also increased. The population increase has taken place even in relatively land abundant arid and semi arid state of Rajasthan. This unprecedented rise in human population and livestock population has resulted in changes in land use and intensity of land use. It has been realized that the scope for extension of land for cultivation is limited. Thus our attention goes to under-used and unused lands (cultivable wastelands), which are of high proportion in Rajasthan. Hence need is felt to study the status and scope for spatial aspects and factors affecting cultivable wastelands..

This study focuses on the spatio-temporal trend of underutilized lands (cultivable wastelands) in Rajasthan. The study also looks at the determinants of spatial extent of underutilized and degraded lands and reviews of the management policies of the state government. The analysis has been done at the district level because district is the smallest unit of administration at which data useful for our analysis on various socio-economic variables is published and important planning unit to which funds flow from central and state governments. The temporal changes of the extent of underutilized lands have been performed for the time period 1980 to 2001. The time period has been selected so because various land development and reclamation were under implementation (DPAP and DDP) and some were started during this period like NWDPRA, IWDP, TDEP etc. These programmes are under implementation through different agencies like Ministry of

Environment and Forests, Department of Land Resources under Ministry of Rural Development, Ministry of Agriculture and some non-governmental organizations.

5.2. Summary of Findings

The second chapter focuses on the spatio-temporal trends of underutilized and degraded lands in Rajasthan. The analysis highlights that there is significantly high proportion of underutilized lands in western arid (34.4 percent) and southern plains (18.58 percent) agro-climatic zone of the state. There is less underutilization of land in the eastern plains agro-climatic zone of Rajasthan. The study compares the two most common estimates of cultivable wasteland (underutilized lands) and degraded land, Ministry of Agriculture (MoA) data on land use on one hand and data produced by NRSA for Department of Land Resources. The two estimates are comparable at the state level but there are significant variations at the district level. The four districts of districts of western Rajasthan have very high MoA estimates than NRSA. These show abnormally high M0A estimates, because the remote sensing imagery estimates by NRSA may have misinterpreted some land uses, because of the timing of the imagery. The imagery if taken at a time when crops have been harvested then it will show high current fallow as some of the culturable waste might be interpreted as current fallow because of similar condition of absence plant cover. The rest of the districts of western Rajasthan show less mismatch, and the percentage between the two (MoA/NRSA) ranges from 80-100 percent i.e. Ministry of Agriculture estimates are slightly lesser than NRSA estimates. The districts of eastern Rajasthan and Ganganagar, hanumangarh districts of northern Rajasthan have significantly low MoA estimates than that of NRSA. These districts have favourable resource endowments and better irrigation infrastructure. Thus here is less risk of crop failure. This serves as motivation for the farmer to put otherwise degraded lands under some use. Thus the mismatch between the two data is partly because of the differences in the methodology adopted, one is based on the farmer's reporting (MoA) and another depends entirely on the bio-physical properties (solar reflectance in different wavelengths). The farmers perception is influenced by variables like land productivity and cost of production in the area, favourable resources (rainfall) and infrastructure development. A favourable combination of all these variables may enable a farmer to conceive a partially degraded land as of use because he gets high returns and thus may be induced to invest in land development measures on his own. The extent of cultivable wastelands by causal processes shows a distinct spatial pattern, with high occurrence of those created by natural processes in western Rajasthan whereas; their proportion goes down moving eastwards. There is predominance of wastelands created by man-made processes in the eastern plains agro-climatic zone.

The temporal analysis over the period 1980-2001 shows that there has been significant decline in the extent of underutilized lands. Most of this decline has been because of the decline in culturable waste as fallow other than current has remained almost stagnant during the period. Culturable waste separately have recorded maximum decline from 18.75 percent to 13.16 percent. The highest decline in culturable waste has been observed in districts of western Rajasthan like Bikaner (22.29 percent), Ganganagar (10 percent) and Jaisalmer (6.94 percent). These districts are under the command area of Rajasthan Canal Project. The extension of irrigation facilites and implementation of command area development programme have contributed to significant reclamation of culturable waste in these districts.. This can be inferred from the significant increase in net sown area in districts of Bikaner and Jaisalmer.

Fallow other than current fallow have recorded minimal decline and still account for a significantly high proportion of the geographical area of the state. This is partly because of the significantly high contribution of these lands to livestock grazing, after deterioration of common pasture lands. When there is low productivity and high risk of crop failure then incentive to bring such land under plough is very low.

The corresponding changes in other land use of the state shows that there has been increase in net sown area, non-agricultural uses and forests. The rest of land uses have remained fairly stagnant except the considerable decline in barren and unculturable waste. The almost two percent points decline in barren and unculturable waste is significant. The overall land use change during the period shows a positive change as both the net sown area and area under forests has increased which is a desirable situation and at the same time there is decline underutilized lands and barren and unculturable waste.

The third chapter analyzes the determinants of extent of underutilized and degraded lands. It also compares the determinants of land degradation and underutilization. The results show that the processes of underutilization of land and land degradation are almost similar in Rajasthan. The determinants of different categories of degraded lands show that each process is a localized phenomenon. The results show that climatic variables like rainfall and rainfall variability although doesn't exhibit direct relationship with total degraded cultivable wastelands but they have significant relationship with some categories like desertic sands. Desertic sands are the result of very low rainfall, which in turn lead to poor vegetation cover and poor development of the soils. The scant rainfall is highly erratic also. Similarly man-land ratio, affects directly the extent of land with or without scrubs as high population pressure leads to the removal of the vegetal cover and making it vulnerable to wind and water erosion, which leads to land with or without scrubs. These are not caused by lack of rainfall i.e. dry and arid conditions. This is confirmed by positive relationship with annual rainfall. This is a major category of degraded land in the state. The negative relationship of land with or without scrub with net sown area and forest cover shows that favourable resource variables would prevent degradation, as high cover of vegetation over the soil will prevent erosion of the otherwise loosely held soil of the desert region. Degraded notified forest areas are positively associated with irrigated area and average annual rainfall, which shows that increased irrigation facilities add extra pressure on the forests for grazing, demand for fuel wood etc. The resultant overexploitation leads to the degradation of the health of the forests. The direct relationship of degraded forests with the annual rainfall confirms our earlier result that it is the human activities that cause degradation of forests and not the adverse impact of low precipitation alone. These different relationships of different categories of degraded land with various factors affecting degradation of land confirm that degradation is localized phenomenon and depends upon different processes. These processes in turn depend upon man environment interaction in the area. The dynamics of land degradation thus can be understood only through micro level studies. Therefore there is need to work with primary data and incorporate farmers perspective because they live off the land and their involvement is necessary for success of land development and reclamation programmes.

The fourth chapter focuses on analysis of land management policies. In the comparison of land management policies of the central and state governments, the results show that the approaches and strategies for land management in the state five-year plans and national five-year plans have been mostly similar. The state policies addressed the environmental issues in agriculture from the second five-year plan onwards whereas they got attention in the national plans relatively late. The review of the land development and reclamation programmes shows that these are run by three different agencies; Ministry of Agriculture, Ministry of Environment and Forests and Ministry of Rural Development at the national level and corresponding ministries at the state level. The different programmes differ in their focus areas. The Ministry of Rural Development focus on the development/reclamation of common lands, forest department on notified forest and pastures and also promotes afforestation on private lands and Ministry of Agriculture provides credit for development/reclamation of private lands of farmers.

The comparison of the requirement of particular region and expenditure showed substantial discrepancy. During the seventh five year planThe situation has improved over time (seventh five-year plan to nineth five-year plan) showing greater correlation between requirement and expenditure.

5.3. Policy Implications

The major findings of the study have some policy implications for sustainable management of land resources in Rajasthan.

Firstly, there are considerable differences between various estimates of cultivable waste. Various estimates emphasize one aspect or the other as a result none of them is all comprehensive and could serve as basis of policy interventions. Thus there is need to have a uniform and regular source of data so that timely monitoring and evaluation can be made.

Secondly, there are a multitude of agencies implementing various land development and reclamation programmes and each has its special focus in Rajasthan. The ecosystem is integrated and it cannot be compartmentalized. Hence there is need to ensure proper coordination between different departments or to integrate all programmes into a holistic programme aimed at sustainable development of natural resources. The watershed approach adopted in various area development programme envisage this but funding through different department for separate treatment of private and common lands cannot bring desired results because all the natural and social resources are integrated in ecosystem..

Thirdly, the extension of irrigation facilities has a significant impact on the decline of culturable waste. Thus efforts should be made to increase irrigation facilities. There does not seem possibility of undertaking any major irrigation project since river water resources are scarce in the state. Minor irrigation projects can be undertaken based on rainwater harvesting structures as there is sufficient runoff along the slopes of hilly area. The revival of traditional rainwater harvesting structures could be very helpful as the technology is of low cost and have evolved indigenously. Some lesson can be learnt from the efforts of *taruna bharat sangha's* efforts for revival of rainwater harvesting in some parts of Alwar district.

Fourth, since resource based variables contribute to prevention of degradation hence government efforts should be towards afforestation on a large scale. The afforestation need to be encouraged on private lands also. There greater emphasis need to be on pasture development so that pressure on the agricultural land is reduced.

Fifth, the financial allocations should take care of the ecological, economic characteristics of different areas preferably at the block level. The analysis point out that the resource allocations have not been consistent with the requirement of districts based on ecological and economic condition. Thus there is need to allocate resources according to the requirements. Higher priority should be given to regions with high extent of degraded and underutilized lands like western arid and southern plains agro-climatic zones.

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Appendix-I Area under Culturable Waste, Current Fallow, Fallow Other than Current Fallow in Rajasthan (1979-83)

	1979-80			1980-81			1981-82			*1982-83*		
district	**CWL**	**FOCF**	**CF**	**CWL**	**FOCF**	**CF**	**CWL**	**FOCF**	**CF**	**CWL**	**FOCF**	***CF***
Ajmer	106134	57005	50237	109971	57640	54520	105208	52589	47944	103307	45998	*48384*
Alwar	17610	57005	50237	16342	57640	54520	16286	52589	47944	17147	20588	*28892*
Banswara	7768	39990	23395	20284	27389	21933	18433	26487	18685	20066	24792	*18999*
Barmer	375054	316386	268387	334779	343489	218055	324484	329225	242599	321375	319918	*268111*
Bhratpur	21196	30816	140252	20683	31250	42070	20664	29264	50524	5904	14051	*25709*
Bhilwara	23067	58537	29905	236849	55200	54144	235065	60301	43044	22478	48931	*31657*
Bikaner	1401221	160501	167596	1390824	183540	101458	1327090	166688	134767	1293368	149810	*143242*
Boondi	30703	57005	50237	33546	57640	54520	34092	52589	47944	34627	21508	*20502*
Chittorgarh	226230	24658	19129	226814	23457	24725	219727	24704	17033	217913	19716	*15774*
Churu	64138	194428	426747	49113	129126	91118	41587	98403	95859	30497	101664	*128723*
Dungarpur	24489	23770	10864	24785	24310	13711	25423	17844	9795	23790	19521	*11714*
Ganganagar	247057	48507	401108	222194	40115	129021	182314	44395	78260	180439	38066	*113630*
Jaipur	77933	113573	153043	80146	111711	99215	83461	90095	95093	80753	78958	*89812*
Jaisalmer	3002198	32896	26964	2970614	43582	23746	2895753	62972	83265	2901840	76526	*56774*
Jallore	9082	127755	123506	21582	123765	136998	29	124710	93514	26622	101611	*120998*
Jhalawar	77717	10498	10313	75235	9901	16286	72257	10706	8176	75290	11587	*8577*
Jhunjhunu	5197	20577	37120	13744	11769	23037	6728	15776	18073	7152	16445	*21754*
Jhodpur	30185	472903	272440	38696	403849	232550	131541	383937	266551	115610	398637	*292992*
Kota	66738	46616	37114	66574	42174	67700	36131	66927	29087	57171	37120	*29071*
Nagaur	3318	128621	328224	20323	99396	230225	17610	93613	241265	33791	86150	*233636*
Pali	17048	143263	137879	54817	146161	156404	50172	147260	145771	45633	119440	*116293*
S.Madhopur	34288	25767	58137	33077	28805	39623	31574	25019	41934	30510	21837	*29238*
Sikar	13957	54616	100802	12655	48115	66441	15443	35728	60966	14768	38468	*62014*
Sirohi	6352	33837	30698	26054	19676	36107	6933	37925	26988	9366	32727	*27042*
Tonk	57791	21312	29855	58776	23331	70230	57884	24153	29306	59470	18405	*29480*
Udaipur	251703	51562	28844	257113	52569	50337	250677	51683	34535	250547	1920199	*2020918*
Dholpur	0	0	0	0	0	0	0	0	0	13914	11101	*13253*
Dausa												

Appendix-II Area under Culturable Waste, Current Fallow, Fallow Other than Current Fallow in Rajasthan (1983-87

	1983-84			1984-85			1985-86			1986-87		
	CWL	FOCF	CF	CWL	FOCF	CF	CWL	FOCF	CF	CWL	FOCF	CF
Ajmer	100610	46652	44609	101454	51461	55941	86115	40587	80683	82748	60670	72182
Alwar	15639	20094	24652	15733	21160	26722	14715	17656	19466	12998	18654	33640
Banswara	18076	24068	16000	17894	24404	17264	18516	25455	18366	17741	30761	16444
Barmer	290101	296919	247085	275528	313388	253589	287217	323448	244202	261173	358663	259543
Bhratpur	5925	11411	20296	219862	14750	15831	6000	9984	12947	5547	26494	37270
Bhilwara	22241	47141	39941	219862	51241	48743	211285	54515	42642	209774	58383	51297
Bikaner	1157520	211412	103098	1248083	195236	25592	1274103	251544	179170	1105691	253787	113785
Boondi	35097	18524	23963	37313	22402	29386	35022	22797	19489	40567	21720	36983
Chittorgarh	213815	21610	18960	214044	21292	20499	217240	18725	21821	216855	23554	37320
Churu	30513	103367	113950	28576	130012	171158	28933	142164	114113	28153	115034	112425
Dungarpur	23974	18536	10751	24635	16526	11811	25991	20964	20251	16940	21847	17333
Ganganagar	82264	37020	81310	158079	57401	101933	115871	140167	56984	87359	110404	62671
Jaipur	79940	80967	100259	78706	90635	108391	76070	187727	81384	72452	181895	78491
Jaisalmer	2822260	132817	36855	2931900	63897	104439	2909003	136233	52255	2927588	117157	44141
Jallore	26161	81184	85847	28991	81974	180901	27537	87408	113398	23981	87513	117902
Jhalawar	67445	12521	9915	67949	12988	12442	67192	13932	9910	66650	14817	26957
Jhunjhunu	7780	14991	20966	7606	16041	23475	6972	15937	20359	6930	14506	22258
Jhodpur	55248	297663	347033	87669	432386	396582	80511	472735	275975	62974	482726	241291
Kota	58233	30584	28379	55672	32769	37117	57612	28880	23905	61662	34771	97724
Nagaur	11740	89499	233768	32510	93398	318048	26266	101015	236716	18471	75663	240026
Pali	43612	90824	93777	44902	100872	150598	44506	120254	127176	46232	103929	114898
S.Madhopur	31231	20937	28361	30040	22845	42809	49852	20798	21642	30826	15691	55153
Sikar	14078	42864	61151	15285	47108	72477	14888	47849	50486	15373	42512	57399
Sirohi	11429	25425	18390	9025	23148	26077	12829	46358	25430	12239	46477	32102
Tonk	59028	17177	34182	56773	18936	39029	53617	116710	18039	52128	115687	20322
Udaipur	242955	1854810	1915214	245673	2024373	2505331	245405	407043	63150	247676	408359	70297
Dholpur	13662	11314	12763	13803	11128	12914	14765	10563	10883	13613	10918	13091

Appendix -III Area under Culturable Waste, Current Fallow, Fallow Other than Current Fallow in Rajasthan (1987-91)

		1987-88			1988-89			1989-90			1990-91	
	CWL	FOCF	CF	CWL	FOCF	CF	CWL	FOCF	CF	CWL	FOCF	CF
Ajmer	84535	73354	83179	77339	67949	49500	73140	61032	56132	68294	50923	44280
Alwar	11311	24989	97988	12612	18553	25579	12637	18559	39916	12475	12415	24531
Banswara	18397	36510	20036	17387	31981	11804	18938	29540	13368	19384	28379	10894
Barmer	338816	530177	896879	280967	489623	119949	261055	381793	241406	266119	329060	216778
Bhratpur	4877	12180	24894	4407	10696	16900	4051	9979	19590	3449	8768	12295
Bhilwara	212421	66557	59864	197183	61393	42824	187502	56683	39617	176912	54036	35145
Bikaner	1191445	288967	433024	1097421	227232	82222	1060405	178903	157259	1075684	177931	207895
Boondi	40569	26550	26206	38180	24940	16816	39685	27026	45936	36597	24478	17639
Chittorgarh	219447	24725	31850	207304	24913	24511	199298	23678	21634	194240	22513	19156
Churu	40840	165148	390012	25422	105636	72710	27094	85516	12348	23484	82262	88272
Dungarpur	27986	30455	35558	27157	23006	12197	26806	24953	13367	25173	24785	9279
Ganganagar	91705	114160	148928	77328	64614	87031	82136	76530	245595	75173	98727	173893
Jaipur	73977	184655	113640	64210	79441	69224	62081	73099	116485	55238	71720	72065
Jaisalmer	2956520	123688	156485	2923790	96499	18057	2915045	84101	31723	2902585	88974	40382
Jallore	24005	163258	323260	22370	122652	66426	26316	103749	116023	25563	87647	94434
Jhalawar	66057	16323	11235	67251	16051	12070	66351	16760	22734	66598	16599	13183
Jhunjhunu	6751	18369	41259	7591	12874	18772	6143	16686	23739	5920	18255	14041
Jhodpur	72845	588039	593541	84271	376631	277625	78879	369894	287759	66717	343928	258296
Kota	56110	34769	27367	612185	32577	34730	59345	38048	82427	66750	34375	28611
Nagaur	19820	126288	392922	16833	79689	185233	16542	68590	194733	14696	63282	191746
Pali	48274	152793	228389	44720	110564	88011	47077	121637	129228	39645	101221	78870
Sawai Madhopur	32230	27902	48886	29030	24307	31534	30154	30981	105255	29625	23466	23861
Sikar	13912	43793	126970	10630	40636	56950	11852	40121	60415	9872	41588	50380
Sirohi	17356	51410	48357	12823	43297	23793	14727	39798	26018	9895	29785	19840
Tonk	52351	116140	22071	47684	17565	32347	47235	205509	77379	43431	18300	26840
Udaipur	249416	410930	86267	247821	72885	38810	239429	69297	35164	233447	64762	30863
Dholpur	13587	12284	16264	13706	11764	11285	14448	14200	14302	14264	12180	8854

Appendix-IV

Area under Culturable Waste, Current Fallow, Fallow Other than Current Fallow in Rajasthan (1991-93)

		1991-92			1992-93	
	CWL	FOCF	CF	CWL	FOCF	CF
Ajmer	68743	51933	56150	69576	51452	44606
Alwar	12568	13455	26550	11948	14379	19968
Banswara	17492	28182	18197	17286	33689	11381
Barmer	284491	362304	351559	33016	23842	17571
Bhratpur	3417	10209	13359	3502	8586	8728
Bhilwara	177651	55958	47607	172904	59309	43334
Bikaner	1042600	298976	310576	976292	179899	91288
Boondi	37240	23208	23734	36993	22930	16715
Chittorgarh	192810	23648	23386	190064	24320	13903
Churu	21614	85582	125070	17351	80486	104918
Dungarpur	24513	23416	11529	25491	24029	13358
Ganganagar	81341	152336	249200	71754	81200	102612
Jaipur	42997	52746	75177	38563	53032	64845
Jaisalmer	2907045	93288	52953	2867114	66829	13816
Jallore	24778	97106	109428	22380	23414	83699
Jhalawar	67288	18331	17199	63749	17758	9252
Jhunjhunu	6121	19419	20299	6023	19071	15658
Jhodpur	68197	357017	344994	50676	30398	232626
Kota	26373	15490	17538	24984	14974	11478
Nagaur	14311	59694	208123	12647	65946	186754
Pali	41648	102571	98886	39050	91794	81798
Sawai Madhopur	29583	22217	37906	27624	20304	21658
Sikar	11565	41674	52589	10800	39212	45279
Sirohi	9206	32030	29895	7367	27747	22705
Tonk	43739	169505	41710	41508	18795	28850
Udaipur	12816	49893	34669	128212	52742	27802
Dholpur	14681	11924	9149	14464	12710	6991
Dausa	8651	12084	16115	9388	11142	12028
rajsamand	121553	19127	9189	116233	20707	7725
Baran	30261	24317	25633	33016	23842	17571

Source:Agricultural Statstics

Appendix-V Area under Culturable Waste, Current Fallow and Fallow Other than Current Fallow in Rajasthan (1997-2001)

		1997-98			98-99		99-00			2000-01		
	CWL	FOCF	CF	CWL	FOCF	CF	CWL	FOCF	CF	CWL	FOCF	CF
Ajmer	69371	44019	36866	71756	46014	40292	77182	54646	72675	75817	62875	67513
Alwar	8589	12566	13637	8419	12422	13891	9046	12953	14301	3123	12358	23073
Banswara	20275	37001	8574	21810	39270	6554	22395	37677	7564	23267	54509	18574
Barmer	232106	364492	251634	262548	464565	414461	265989	485066	327214	265989	485066	327214
Bharatpur	3002	8902	8220	2952	9022	7936	2897	9010	6792	1901	7839	15389
Bhilwara	160110	65874	42690	163243	70987	56484	163187	77347	61260	159472	71792	55655
Bikaner	791565	223850	119181	817256	235790	228669	787970	277993	192578	787970	277993	192578
Bundi	33539	21337	12666	33607	20603	15681	33153	22184	15424	15402	32115	28453
Chittorgarh	179472	24275	18971	181684	25208	20146	176090	26910	19863	119502	52378	35579
Churu	12850	72389	83579	14324	81171	104995	15041	86842	245760	10432	78741	101754
Dholpur	12878	9886	7467	11974	9786	7984	11999	9698	9115	11999	9698	9115
Dungarpur	23701	28774	9078	25184	32809	12268	24215	36424	6997	9254	31130	16555
Ganganagar	60633	68128	82281	56172	76719	83855	54945	86797	399285	1417	166275	298938
Jaipur	40965	54077	53714	38265	49642	59664	39267	60442	79828	12461	60364	129560
Jaisalmer	2784006	82092	54918	2776205	105559	95539	2719572	126484	40255	2719572	126484	40255
Jalore	27841	100872	82766	32227	122289	170673	32052	152988	154067	32052	152988	154067
Jhalawar	56423	19478	8440	56251	19841	8278	55006	20362	7587	52923	20005	11491
Jhunjhunun	5883	16571	12713	5921	17155	11809	6003	18755	24719	11560	24539	25973
Jodhpur	46020	344299	269363	40800	425859	392945	41337	424501	375735	97900	341141	291482
Kota	56878	38087	22856	54050	35680	20056	53907	32429	24844	18251	31151	53321
Nagaur	12596	75201	164882	13653	83010	190548	13527	99775	218077	15334	96697	220742
Pali	39599	92580	82955	41277	106256	110905	46711	125297	140547	59158	99659	155225
Sawai Madhopur	26642	19233	18247	25480	18639	16762	24972	18463	16943	44854	24457	71491
Sikar	9443	33086	42204	9328	38544	47623	9857	43263	54855	2031	42242	53176
Sirohi	8470	31973	27464	8498	37172	38349	8980	46405	47273	3139	52171	37082
Tonk	42888	19030	26372	43498	19450	25623	45627	19930	34497	7006	31760	92573
Udaipur	251362	80153	35253	252873	83803	35545	246527	97942	38990	55391	156461	48894
Rajasthan	5017107	1988225	1596991	5069255	2287265	2237535	4987454	2510583	2637045	4504756	2295797	2272506

Appendix-VI

Districtwise Plan Expenditure on Watershed Developmennd Soil Conservation Measures by during Seventh Five Year Plan (Rupees in lakhs)

	1985-86	1986-87	1987-88	1988-89	1989-90
Ajmer	0.6	0.66	0.64	0.77	0.38
Alwar	1.66	0.23	2.84	0.47	5.76
Banswara				0.39	0.25
baran					
Barmer				0.28	1.07
Bharatpur	3.26	6.44		9.35	9.39
Bhilwara	0.88	0.82		0.31	0.33
Bikaner		0.82		0.31	0.33
Bundi	0.83	0.45		0.06	
Chittorgarh	0.83	0.83	0.1	0.69	0.36
Churu	1.13				
Dholpur	1.7	7.62	4.78	3.27	3.92
Dungarpur		0.2	0.54	0.29	0.21
Ganganagar					
hanumangarh					
Jaipur	3.21	25.61	17.7	9.48	12.74
Jaisalmer				0.08	0.64
Jalore	0.85			0.5	0.56
Jhalawar		0.35		2.14	0.15
Jhunjhunu	9.22	0.08		0.23	0.25
Jodhpur	4.25	0.88		2.56	3.66
karauli					
Kota	0.85	6.13	3.72	3.5	7.12
Nagaur	2.55			0.27	0.27
Pali	1.66	0.36		0.3	0.94
rajsmand					
S. Madhopur	1.66	14.27	8.69	12.55	9.41
Sikar	12.04	0.1		0.54	1.41
Sirohi	0.83	0.4	0.1		0.08
Tonk	0.83	0.43	0.11	0.23	0.55
Udaipur		1.63		0.84	0.34
undistrib		50	67.79	52.5	
Rajasthan	48.84	118.31	107.01	101.91	60.12

Source: Seventh five-plan(1985-1990), Districtwise Expenditures and Physical Achievements, Planning(gr.III) Department, Secretariat,Jaipur

Appendix-VII

Indicators for Calculating Ecological Fragility and Economic Need

District	non_wasteland	rainfall	Above poverty pop.	Prod/ha(Rs)	NSA	f_1	f_2	f1+f2
Ajmer	62.08	60.18	87.7	3516	43.29	-0.290	-0.296	-0.586
Alwar	78.27	65.73	90.2	7577	65.99	0.585	1.137	1.722
Banswara	77.96	95.03	72.1	4466	45.56	-0.720	0.728	0.008
Barmer	67.57	26.57	76.8	629	46.29	0.000	-1.736	-1.735
Bharatpur	88.64	66.39	90.3	7643	77.95	1.176	1.384	2.560
Bhilwara	69.47	68.32	90.2	7025	32.42	-0.549	0.675	0.126
Bikaner	87.56	24.3	88.7	1239	38.99	0.741	-1.386	-0.646
Bundi	62.04	77.34	78.2	8713	44.39	-1.010	1.163	0.152
Chittaurgarh	76.77	84.15	77.3	7805	38.57	-0.825	1.204	0.379
Churu	90.26	35.47	81.6	1155	71.84	1.351	-0.897	0.454
Dholpur	55.06	74.45	88.5	8018	49.85	-0.625	1.029	0.404
Dungarpur	72.35	72.89	56.7	5103	30.90	-1.637	0.012	-1.625
Ganganagar	83.96	22.64	94.8	7392	63.58	1.231	0.200	1.432
Jaipur	80.17	56.38	90.6	4885	61.55	0.748	0.307	1.056
Jaisalmer	12.26	18.55	80	2603	9.21	-2.376	-2.353	-4.729
Jalore	89.52	37	88.1	2642	50.07	0.885	-0.669	0.216
Jhalawar	70.18	84.43	68.9	4322	49.63	-0.826	0.378	-0.447
Jhunjhunu	85.88	40.51	80.6	2513	72.12	1.095	-0.533	0.562
Jodhpur	69.85	31.37	82.5	1389	47.02	0.199	-1.366	-1.167
Kota	69.10	73.24	82.5	6061	48.54	-0.391	0.634	0.243
Nagaur	87.13	31.77	86.4	2617	68.02	1.295	-0.672	0.623
Pali	74.59	42.44	88.2	3826	44.25	0.229	-0.487	-0.259
S.Madhopur	77.01	87.34	96.4	7242	48.85	0.129	1.450	1.578
Sikar	83.17	44.33	83.2	3113	66.47	0.898	-0.364	0.533
Sirohi	65.03	59.12	87.5	5215	24.47	-0.802	-0.085	-0.887
Tonk	79.26	66.83	92.5	4921	66.23	0.821	0.607	1.428
Udaipur	77.40	64.5	70.4	5317	16.93	-1.333	-0.062	-1.395

Source: wasteland from NRSA 'Wasteland Atlas'

Above poverty line population = 100-rural poverty ratio s obtained from Rajasthan Human development report 2002

Productivity from CMIE District Profile

Normal Rainfall from Yaseen khan's 'Dryland Ecology and Climate' rawat pub. jaipur

Appendix-VIII
Districtwise Expenditures on Watershed Development and Soil Conservation Measures by Agriculture Deptt.
Nineth plan (1997-2001) (Rupees in lakhs)

district	1997-98	1998-99	1999-00	2000-01	2001-02	9th plan
Ajmer	26.89	49.6	53.01	14.8	14.09	131.5
Alwar						0
Banswara	16.62	30.72	33.94	73.34	69.8	207.8
baran						0
Barmer	8.31	30.53	15.57			46.1
Bharatpur						0
Bhilwara			0.07	1.08	1.03	2.18
Bikaner	8.31		14.7	15.85	15.09	45.64
Bundi						0
Chittorgarh						0
Churu						0
Dholpur						0
Dungarpur	18.58	23.81	29.17	51.02	48.56	152.56
Ganganagar						0
hanumangarh	8.31		14.27	18.1	17.23	49.6
Jaipur			3.99			3.99
Jaisalmer	8.31		13.58			13.58
Jalore	8.31	6.42	11.07			17.49
Jhalawar	18.58	23.52	23.77	15.47	14.72	77.48
Jhunjhunu		15.21				15.21
Jodhpur	8.31	15.05	24.48	14.11	1.06	54.7
karauli				14.19	13.51	27.7
Kota	10.27	17.43	23.36	18.87	17.96	77.62
Nagaur	16.62	41.08	30.05			71.13
Pali	18.58	31.73	30.1	34.25	32.6	128.68
rajsmand	10.27			14.54	13.84	28.38
S. Madhopur	8.31		14.09	14.92	14.2	43.21
Sikar	8.31		16.16	13.85	13.18	43.19
Sirohi						0
Tonk	10.27		10.91			10.91
Udaipur	16.62		34.86	63.5	60.47	158.83
undistrib	170.22	123	56.07	167.55	102.66	449.28
rajasthan	**400**	**408.1**	**453.22**	**545.44**	**450**	**1856.76**

Source: Annual Plans1997-2001, Districtwise Expenditures and Physical Achievements, Planning(gr. III) Deptt, Secretariat, Jaipur

Appendix-IX

Districtwise Expenditure on Watershed Development and Soil Conservation Measures by Forest Deptt.Nineth Plan (Rupees in lakhs)

District	1997-98	1998-99	1999-00	2000-01	2001-02	9th plan
Ajmer	6.49		4.02	3.49	2.5	16.5
Alwar	2.1		2			4.1
Banswara	3.35		2.02	2.92	3.97	12.26
Baran	1.52			2.17	2.65	6.34
Barmer						0
Bharatpur	0.4			0.53	0.58	1.51
Bhilwara	2.3			3	3.5	8.8
Bikaner		744.15				744.15
Bundi	6.15		0.35	0.39	0.2	7.09
Chittorgarh	2		8.25	3.17	3	16.42
Churu						0
Dausa	3.05		0.29	0.08		3.42
Dholpur	10.37		9.44	13.37	9.5	42.68
Dungarpur	0.55		0.24	0.38		1.17
Ganganagar						0
Hanumangarh		43.37				43.37
Jaipur	14.75		9.83	4.37	6.15	35.1
Jaisalmer		772.22				772.22
Jalore						0
Jhalawar						0
Jhunjhunu						0
Jodhpur		263.32				263.32
Karauli			0.78	0.32	0.3	1.4
Kota	5.67		0.49	0.36	1.66	8.18
Nagaur						0
Pali						0
Rajsmand	0.2		0.13	0.15		0.48
S.Madhopur	5		0.25	0.16	0.1	5.51
Sikar			3.4	1.13	0.2	4.73
Sirohi	1.16			0.85	1.47	3.48
Tonk	1.3		1.76	1.92	2	6.98
Udaipur	0.35			0.41	0.5	1.26
Undistributed	8.35		1.55		1.72	11.62
Rajasthan	75.06	1823.06	44.8	39.17	40	2022.09

Source: Annual Plans 1997 to 2002, Districtwise Expenditures and Physical achievements, Planning(gr.III) Department, Secretariat,Jaipur

Appendix-X

Districtwise Plan Expenditure on Watershed Developmennd Soil Conservation Measures during Seventh Five-Year Plan(Rupees in lakhs)

	1985-86	1986-87	1987-88	1988-89	1989-90
Ajmer	0.6	0.66	0.64	0.77	0.38
Alwar	1.66	0.23	2.84	0.47	5.76
Banswara				0.39	0.25
baran					
Barmer				0.28	1.07
Bharatpur	3.26	6.44		9.35	9.39
Bhilwara	0.88	0.82		0.31	0.33
Bikaner		0.82		0.31	0.33
Bundi	0.83	0.45		0.06	
Chittorgarh	0.83	0.83	0.1	0.69	0.36
Churu	1.13				
Dholpur	1.7	7.62	4.78	3.27	3.92
Dungarpur		0.2	0.54	0.29	0.21
Ganganagar					
hanumangarh					
Jaipur	3.21	25.61	17.7	9.48	12.74
Jaisalmer				0.08	0.64
Jalore	0.85			0.5	0.56
Jhalawar		0.35		2.14	0.15
Jhunjhunu	9.22	0.08		0.23	0.25
Jodhpur	4.25	0.88		2.56	3.66
karauli					
Kota	0.85	6.13	3.72	3.5	7.12
Nagaur	2.55			0.27	0.27
Pali	1.66	0.36		0.3	0.94
rajsmand					
S. Madhopur	1.66	14.27	8.69	12.55	9.41
Sikar	12.04	0.1		0.54	1.41
Sirohi	0.83	0.4	0.1		0.08
Tonk	0.83	0.43	0.11	0.23	0.55
Udaipur		1.63		0.84	0.34
undistrib		50	67.79	52.5	
Rajasthan	48.84	118.31	107.01	101.91	60.12

Source: Seventh five-plan (1985-1990), Districtwise Expenditures and Physical Achievements, Planning (gr.III) Department, Secretariat,Jaipur

Appendix-XI

INDICATORS

District	CWL(10)	Rainfall	Variability	Avg. Size Hldg	Poverty	Man-land ratio	Prod/ha	Forest	NSA	Livestock density	GIA/TCA
Ajmer	37.92	60.18	38.2	2.33	12.3	3.60	3516	6.03	43.29	123.69	24.12
Alwar	21.73	65.73	35.82	1.8	9.8	5.24	7577	8.90	65.99	130.06	55.97
Banswara	22.04	95.03	33.49	1.63	27.9	5.51	4466	21.29	45.56	174.67	24.58
Barmer	32.43	26.57	60.41	12.44	23.2	1.40	629	0.99	46.29	46.18	12.14
Bharatpur	11.36	66.39	35.59	1.76	9.7	4.29	7643	5.69	77.95	134.54	43.63
Bhilwara	30.53	68.32	35.03	2.05	9.8	4.90	7025	7.04	32.42	137.87	32.53
Bikaner	12.44	24.3	59.38	10.83	11.3	1.01	1239	2.87	38.99	37.57	22.73
Bundi	37.96	77.34	38.27	2.42	21.8	3.36	8713	24.13	44.39	113.96	68.10
Chittaurgarh	23.23	84.15	37.24	2.31	22.7	3.75	7805	18.04	38.57	112.16	30.78
Churu	9.74	35.47	44.38	9.56	18.4	1.28	1155	0.48	71.84	49.42	6.28
Dholpur	44.94	74.45	35.52	1.57	11.5	5.38	8018	8.68	49.85	117.00	48.68
Dungarpur	27.65	72.89	36.99	1.37	43.3	9.08	5103	15.88	30.90	176.55	15.69
Ganganagar	16.04	22.64	43.63	7.32	5.2	1.90	7392	3.34	63.58	78.49	78.23
Jaipur	19.83	56.38	35.03	3.09	9.4	4.70	4885	7.12	61.55	135.48	48.15
Jaisalmer	87.74	18.55	66.21	13.1	20	1.22	2603	0.58	9.21	19.04	29.25
Jalore	10.48	37	56.23	6.03	11.9	2.53	2642	1.79	50.07	78.82	38.79
Jhalawar	29.82	84.43	29.32	2.61	31.1	3.88	4322	18.93	49.63	112.82	36.26
Jhunjhunu	14.12	40.51	38.22	2.8	19.4	3.63	2513	6.70	72.12	104.92	39.50
Jodhpur	30.15	31.37	61.44	8.73	17.5	1.80	1389	0.31	47.02	63.62	16.57
Kota	30.90	73.24	29.15	3.04	17.5	2.89	6061	27.40	48.54	90.60	59.74
Nagaur	12.87	31.77	43.13	5.96	13.6	1.89	2617	0.96	68.02	77.67	23.39
Pali	25.41	42.44	44.41	3.93	11.8	2.54	3826	6.45	44.25	90.78	29.23
S.Madhopur	22.99	87.34	53.56	2.06	3.6	4.38	7242	24.18	48.85	103.46	38.97
Sikar	16.83	44.33	38.71	3.08	16.8	3.55	3113	7.76	66.47	115.03	40.83
Sirohi	34.97	59.12	50.57	2.7	12.5	5.29	5215	29.44	24.47	90.04	39.39
Tonk	20.74	66.83	53.26	3.39	7.5	2.08	4921	3.63	66.23	99.30	35.41
Udaipur	22.60	64.5	31.5	1.62	29.6	10.19	5317	22.34	16.93	134.07	19.42

Appendix-XII

Correlations

		MOA	RAINFALL	VARIABIL	FOREST	NSA	HOLDINGS	POVERTY	PRODUCTI	IRRIGATI	MANLAND
MOA	Pearson Correlation	1.000	-.421*	.578**	-.262	-.697**	.645**	.193	-.374	-.591**	-.238
	Sig. (2-tailed)	.	.029	.002	.186	.000	.000	.336	.055	.001	.231
	N	27	27	27	27	27	27	27	27	27	27
RAINFALL	Pearson Correlation	-.421*	1.000	-.639**	.744**	-.073	-.822**	.233	.675**	.260	.598**
	Sig. (2-tailed)	.029	.	.000	.000	.717	.000	.242	.000	.191	.001
	N	27	27	27	27	27	27	27	27	27	27
VARIABIL	Pearson Correlation	.578**	-.639**	1.000	-.462*	-.213	.777**	-.261	-.538**	-.447*	-.581**
	Sig. (2-tailed)	.002	.000	.	.015	.287	.000	.189	.004	.019	.001
	N	27	27	27	27	27	27	27	27	27	27
FOREST	Pearson Correlation	-.262	.744**	-.462*	1.000	-.360	-.606**	.313	.532**	.105	.563**
	Sig. (2-tailed)	.186	.000	.015	.	.065	.001	.111	.004	.602	.002
	N	27	27	27	27	27	27	27	27	27	27
NSA	Pearson Correlation	-.697**	-.073	-.213	-.360	1.000	-.118	-.388*	-.002	.644**	-.326
	Sig. (2-tailed)	.000	.717	.287	.065	.	.556	.046	.993	.000	.097
	N	27	27	27	27	27	27	27	27	27	27
HOLDINGS	Pearson Correlation	.645**	-.822**	.777**	-.606**	-.118	1.000	-.065	-.684**	-.444*	-.701**
	Sig. (2-tailed)	.000	.000	.000	.001	.556	.	.746	.000	.020	.000
	N	27	27	27	27	27	27	27	27	27	27
POVERTY	Pearson Correlation	.193	.233	-.261	.313	-.388*	-.065	1.000	-.173	-.388*	.453*
	Sig. (2-tailed)	.336	.242	.189	.111	.046	.746	.	.389	.045	.018
	N	27	27	27	27	27	27	27	27	27	27
PRODUCTI	Pearson Correlation	-.374	.675**	-.538**	.532**	-.002	-.684**	-.173	1.000	.582**	.449*
	Sig. (2-tailed)	.055	.000	.004	.004	.993	.000	.389	.	.001	.019
	N	27	27	27	27	27	27	27	27	27	27
IRRIGATI	Pearson Correlation	-.591**	.260	-.447*	.105	.644**	-.444*	-.388*	.582**	1.000	.009
	Sig. (2-tailed)	.001	.191	.019	.602	.000	.020	.045	.001	.	.965
	N	27	27	27	27	27	27	27	27	27	27
MANLAND	Pearson Correlation	-.238	.598**	-.581**	.563**	-.326	-.701**	.453*	.449*	.009	1.000
	Sig. (2-tailed)	.231	.001	.001	.002	.097	.000	.018	.019	.965	.
	N	27	27	27	27	27	27	27	27	27	27

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

District	Gullied/Ravinous land	Land with/without scrub	Waterlogged/marshy land	Saline/alkaline area	Shifting Cultivation	Degraded notified forest	Degraded pasture/grazing	Degra	Sands	Mining/ndustrial waste	Barren rocky area	Steep Sloping area	Snow/glacial area	Total Wastelands	Total Geog. area	% to Total Geog. area
Ajmer	124.12	1554	0	386.8	0	480.65	600.94	0	68.81	0.9	121.52	0	0	3337.4	8481	39.35
Alwar	206.07	616.3	0	13.45	0	956.92	1.37	0	20.8	5.99	252.47	0	0	2073.4	8380	24.74
Bikaner	73.19	415.9	35.88	4.05	0	78.84	669.23	0	2098.5	13.77	0	0	0	3389.3	27244	12.44
Banswara	1.83	948.7	0	0.12	0	153.95	5.05	0	0.37	0	0.31	33	0	1143.4	5037	22.7
Barivier	0	1193	0	254.2	0	126.97	1734.7	0	5893.1	3.7	291.3	0	0	9497.1	28387	33.46
Bharatpur	122.7	369.6	0.67	21.24	0	20.97	40.97	0	2.47	0	6.35	19.8	0	604.8	5092	11.88
Bilwara	32.25	1372	0	66.74	0	423.5	1293.5	0	3.63	0	597.1	0.7	0	3789.4	10455	36.24
Bundi	417.52	446.3	0	41.19	0	1045.5	156.42	0	0	0	253.44	8.76	0	2369.2	5550	42.69
Chittaurga	110.31	1469	0	224.5	0	373.69	344.96	0	0	0	166.23	0	0	2688.4	10856	24.76
Churu	0	3.35	0	15.17	0	32.03	1264.8	0	318.39	5.7	1.2	0	0	1640.6	16830	9.75
Dholpur	468.46	743.6	0	0	0	139.31	0	0	0	0.57	5.89	0	0	1357.8	3008	45.14
Dungarpur	0	807.1	0	0	0	214.11	0	21.1	0	0	0.62	0	0	1043	3770	27.67
Hanuman	0	0	108.51	9.43	0	5.55	110.66	0	120.3	2.19	0	0	0	356.64	9656	3.69
Jaipur	859.45	250.2	0	211.2	0	942.67	145.99	0	375.76	4.1	67.84	0	0	2857.3	14068	20.31
Jaisalmer	0	6958	19	119	0	165	0	0	26432	0	905	0	0	34598	38401	90.1
Jalore	56.05	422.3	0	56.98	0	141.86	0	0	438.21	0	130.75	0	0	1246.1	10640	11.71
Jhalawar	242.98	350.3	0	0	0	911.31	350.09	0	0	0	75.08	1.42	0	1931.2	6219	31.05
Jhunjhunu	299.11	134.7	0	0	0	288.67	0	0	114.27	0.37	11.2	0	0	848.27	5928	14.31
Jodhpur	91.46	2197	0	169.6	0	34.93	1267.6	0	3103.8	25.63	90.82	0	0	6981	22850	30.55
Kota	582.64	99.44	0.62	1.09	0	2438.9	679.02	0	0	41.25	222.04	27.3	0	4092.2	12436	32.91
Nagaur	44.82	507.4	0	216.5	0	127.25	862.35	0	504.72	16.52	67.7	0	0	2347.3	17718	13.25
Pali	15.57	928.8	0	668.7	0	616.18	864.67	0	53.96	0	130.35	16.5	0	3294.7	12387	26.6
Madhopur	830.7	139.6	0	3.28	0	1105.6	327.72	0	13.6	0	1040.56	72.8	0	3533.8	10527	33.57
Sikar	123.42	83.79	0	28.74	0	560.14	353.26	0	151.8	0	23.83	0	0	1325	7732	17.14
Sirohi	50.83	424.8	0	0	0	820.54	370.77	0	125.77	3.37	311.79	0	0	2107.9	5136	41.04
ganganag	0	912.6	124.98	0.23	0	0	0	0	722.95	0	0	0	0	1760.7	10978	16.04
Tonk	197.81	80.97	0	210.7	0	241.01	685.07	0	76.37	0	22.52	0	0	1514.5	7194	21.05
Udaipur	1.48	3724	0	0	0	95.83	79.37	0	0	4.59	3.11	2	0	3910.8	17279	22.63
Total	4952.8	27153	289.66	2723	0	12542	12208	21.1	40640	128.65	4799.02	182	0	105639	342239	30.87

Source : Wastelands Atlas of India 2000, Dept. of Land Resources, Ministry of Rural Development, Govt. of India.

Appendix-XIV

District	cwl(10)	rainfall	variability	avg. size hldg	poverty	man-land ratio	Prod/ha	forest	nsa	livestock density	gia/tca
Ajmer	37.92	60.18	38.2	2.33	12.3	3.60	3516	6.03	43.29	123.69	24.12
Alwar	21.73	65.73	35.82	1.8	9.8	5.24	7577	8.90	65.99	130.06	55.97
Banswara	22.04	95.03	33.49	1.63	27.9	5.51	4466	21.29	45.56	174.67	24.58
Barmer	32.43	26.57	60.41	12.44	23.2	1.40	629	0.99	46.29	46.18	12.14
Bharatpur	11.36	66.39	35.59	1.76	9.7	4.29	7643	5.69	77.95	134.54	43.63
Bhilwara	30.53	68.32	35.03	2.05	9.8	4.90	7025	7.04	32.42	137.87	32.53
Bikaner	12.44	24.3	59.38	10.83	11.3	1.01	1239	2.87	38.99	37.57	22.73
Bundi	37.96	77.34	38.27	2.42	21.8	3.36	8713	24.13	44.39	113.96	68.10
Chittaurgarh	23.23	84.15	37.24	2.31	22.7	3.75	7805	18.04	38.57	112.16	30.78
Churu	9.74	35.47	44.38	9.56	18.4	1.28	1155	0.48	71.84	49.42	6.28
Dholpur	44.94	74.45	35.52	1.57	11.5	5.38	8018	8.68	49.85	117.00	48.68
Dungarpur	27.65	72.89	36.99	1.37	43.3	9.08	5103	15.88	30.90	176.55	15.69
Ganganagar	16.04	22.64	43.63	7.32	5.2	1.90	7392	3.34	63.58	78.49	78.23
Jaipur	19.83	56.38	35.03	3.09	9.4	4.70	4885	7.12	61.55	135.48	48.15
Jaisalmer	87.74	18.55	66.21	13.1	20	1.22	2603	0.58	9.21	19.04	29.25
Jalore	10.48	37	56.23	6.03	11.9	2.53	2642	1.79	50.07	78.82	38.79
Jhalawar	29.82	84.43	29.32	2.61	31.1	3.88	4322	18.93	49.63	112.82	36.26
Jhunjhunu	14.12	40.51	38.22	2.8	19.4	3.63	2513	6.70	72.12	104.92	39.50
Jodhpur	30.15	31.37	61.44	8.73	17.5	1.80	1389	0.31	47.02	63.62	16.57
Kota	30.90	73.24	29.15	3.04	17.5	2.89	6061	27.40	48.54	90.60	59.74
Nagaur	12.87	31.77	43.13	5.96	13.6	1.89	2617	0.96	68.02	77.67	23.39
Pali	25.41	42.44	44.41	3.93	11.8	2.54	3826	6.45	44.25	90.78	29.23
S.Madhopur	22.99	87.34	53.56	2.06	3.6	4.38	7242	24.18	48.85	103.46	38.97
Sikar	16.83	44.33	38.71	3.08	16.8	3.55	3113	7.76	66.47	115.03	40.83
Sirohi	34.97	59.12	50.57	2.7	12.5	5.29	5215	29.44	24.47	90.04	39.39
Tonk	20.74	66.83	53.26	3.39	7.5	2.08	4921	3.63	66.23	99.30	35.41
Udaipur	22.60	64.5	31.5	1.62	29.6	10.19	5317	22.34	16.93	134.07	19.42

Appendix -XV

Expenditure per Hectare onWatershed development and Soil Conservation Measure by Forest and Agricultural Deptt

District	9th plan	District	seventh plan
Ajmer	20.62	Ajmer	0.04
Alwar	1.05	Alwar	0.72
Banswara	46.99	Banswara	0.03
Barmer	1.92	Barmer	0.00
Bharatpur	0.19	Bharatpur	0.43
Bhilwara	1.05	Bhilwara	0.02
Bikaner	29.29	Bikaner	0.00
Bundi	1.28	Bundi	0.04
Chittaurgarh	1.51	Chittaurgarh	0.02
Churu	0.00	Churu	0.00
Dholpur	14.07	Dholpur	2.31
Dungarpur	45.71	Dungarpur	0.09
Ganganagar	4.91	Ganganagar	0.00
Jaipur	3.02	Jaipur	0.35
Jaisalmer	20.68	Jaisalmer	0.00
Jalore	2.42	Jalore	0.02
Jhalawar	15.45	Jhalawar	0.07
Jhunjhunu	2.57	Jhunjhunu	0.28
Jodhpur	14.28	Jodhpur	0.02
Kota	8.23	Kota	0.14
Nagaur	4.95	Nagaur	0.01
Pali	11.89	Pali	0.02
S.Madhopur	8.18	S.Madhopur	0.42
Sikar	7.27	Sikar	0.24
Sirohi	0.68	Sirohi	0.05
Tonk	3.91	Tonk	0.04
Udaipur	12.49	Udaipur	0.01