CHAPTER – 5
MINING AND LAND MANAGEMENT
EXTRACTION OF MINERAL RESOURCES AND ENVIRONMENTAL DEGRADATION

Exploration and exploitation of minerals is very essential for the economic and industrial development of any country. In general, mining activities are accompanied by a variety of environmental problems. This process of environmental degradation, which starts with the extraction of minerals resulting in land degradation (Plate 1) and addition of pollutants to air and water, continues as the mineral is beneficiated and processed (Plate 4A). Generally in developing countries like India, mining activity is carried out unsystematically and irrationally (Plate 1). This activity reduces and destroys the biological potential of the land, causing ecological imbalance to the mining sites and ultimately affecting the biodiversity (Fig. 5.1 & Fig. 2.4).

![Diagram of Environmental Discharge Model of Mining Industries]

Table 5.1: Schematic Environmental Discharge Model of Mining Industries
Fig. 5.1: Forest & Mines of Kishangarh Tehsil

Scale: 1 CM = 2.5 KM

[Map of Kishangarh Tehsil showing various locations and minerals]
Mining operations can damage the environment and ecology to an unacceptable degree, unless carefully planned and controlled. Environmental damage due to mining and mineral processing (resulting slurry) can be considered under the following heads:

- Land degradation due to surface mining.
- Land degradation due to underground mining.
- Water pollution due to mining and mineral processing.
- Air pollution due to mining and mineral processing.
- Land disposals of solid waste and refuse dumps.
- Land degradation due to deforestation
- Diminishing flora and fauna, and
- Aesthetic damage due to abandoned mines sites, etc.

**LAND DEGRADATION DUE TO MINING**

The land degradation is due to dump nuisance that are mainly caused by the presence of weak rock foundations, height of the dump, groundwater conditions and steep slopes. During rainy season seeping water from these dumps contaminate surface and subsurface water and reduces land's fertility (Fig. 5.2 & Plate No.1 Fig B) in area Silora, Bandarsundari, Ganeshpura, Mandawaria etc. Dumping of waste causes diversion of streams, deforestation, disappearance of flora and fauna and thus spoils the ecosystem of the area.
Fig. 5.2: Drainage, Water Bodies & Mines of Kishangarh Tehsil
SOURCES OF LAND DEGRADATION

Land degradation is alteration and spoiling of land and landscape and rendering it worthless for any useful purpose including destruction of nature, flora and fauna, etc. This also includes shifting of human habitats, change in physical characteristics to the topography of the areas, change in the existing service facilities and change in the course of water body and also wind flow. Mining of minerals by surface method disturb the land from which it is mined. Unplanned dumping of solid wastes from mines, indiscriminate disposal of mineral based industries, unplanned construction of infrastructure facilities are also potential sources of land and landscape pollution due to mining based activities. Waste generated by two ways in mining industries

a. During Quarrying - These are over burden, side burden, inter burden, ungraded and under size material.

b. During Processing – This includes dressing, cutting and polishing waste. The sludge and slurry generated during processing.

The slurry is a suspension of fines generated during processing and polishing of marble rock. The chemical composition is 28-35% CaO, 10-14% MgO, 1-2.5%o R2 O3, 15-20 % acid insoluble and 35-40% loss on ignition (Sinha, 2000). The slurry of Rajsamand region is characterized by high CaCO3, (40-50 %), alkaline pH (8.9-9.7) and moderate salinity (EC 0.27- 3.01 dS m-1). The slurry particles (50-70 %) are of 150 pm size followed 1.0-22 %, particles of 500 pm, and 9-13 % particles of 25 micron size. The water holding capacity ranges from 20-26% (Joshi & Sharma, 2009). The non-capillary porosity which stores moisture for plant growth is almost nonexistent. The slurry does not contain organic carbon, nitrogen, phosphorus and other nutrients and is also devoid of microbial population. Thus it is a very poor media for plant growth and will not support any kind of vegetation unless favorable rooting environment is created by mixing with soil (Joshi and Paliwal, 2004).

Mining wastelands: Lands where mining operations bring about the degradation of land and resultant mine dumps (waste). Extensive and
concentrated surface mining operations are probably one of the great offenders in creating land degradation. During the study it has been observed that the unstable nature of waste dumps is the most burning and prominent cause of Land Degradation. The stability of waste dumps is a burning issue because it threatens the working of the mine, degrades land and destroys the soil fertility

Factors affecting stability of the waste dumps, broadly, the factors that the effect the dump stability can be classified as,

- Dump Geometry
- Geochemical and Geo-hydrological conditions
- Geo-technical properties of the waste dump material
- Mining equipment and
- Blasting and other ground water movement

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**IMPACT OF LAND DEGRADATION**

Surface mining operation has been an important focal point, if interest in view of their implication on the significant alterations that they generate in and around a mining area. Briefly they are

- Complete alteration of the topography of the earth’s surface, leaving an area of more or less parallel ridges or of mounds of minerals, which overlay the excavated mineral deposits. Spreading of waste and overburden materials from industrial and mine plants over large area make the land unusable and affects the natural harmony, thus contaminating the land.
- Damage to agriculture land- Surface mining of minerals results into a constant decline of cultivable areas, if the mine is situated in such area as it disturbs the land surface consisting different layers of the solid, soils which are in ecological balance with total environment.
- Deforestation- Surface mining of Kishangarh destroys all existing vegetation and results into soil erosion, land slips etc. and also the
changes the existing ecosystem some of the important plants may permanently become extinct (Fig. 5.1).

- Damage of landscape with the development of high technology and improved blasting, surface mining operations have been expanded to more prominent locations and to areas of more valuable land.
- Appearance after mining, the area consisting of varying percentage of debris and soil materials, become devoid of all plants and animal life. These mined out area remain bare and barren years after years.
- Socio-economic impacts-such as loss of farmlands and displacement of farmers along with loss of forest and forest products also occurs due to land degradation.
- Other impact such as population increase in the area, health issues, cost of living and changes in community also occurs.
- Although the area occupied for mining spread over the tehsil in small patches yet the damage to the environment on account of mining is causing grave concern. Environmental degradation resulting from mining activity in general can be briefly enumerated as follows:
  - Air pollution with dust and gases due to drilling, blasting, mine haulage and transportation by road, and also from waste heaps;
  - Modifying water regimes such as surface flow, groundwater availability and lowering down of water table (Fig. No. 6.1 & Fig 6.2)
  - Soil erosion, soil modification with dust and salt;
  - Noise and vibration problem in the mine and adjoining habitat including wild life;
  - Alteration of the landform;
  - Deforestation affecting flora and fauna; and
  - Spoiling aesthetics with untreated waste dumps.

THE DAMAGE TO THE ENVIRONMENT WITHIN ACCEPTABLE LIMITS OR SUSTAINABLE DEVELOPMENT

It is reasonable and relevant to examine the causes of critical
effects due to mining activity, not only day-to-day basis, but on the basis of future impacts also. Nevertheless, Eco-friendly and 'Sustainable Development' milling is one of the solutions for damage to be contained within acceptable limits. The 'Eco-friendly' and 'sustainable Development Mining consists as following:

a. Scientific Mine Planning-Planning ensure the effective utilization of the deposit and provides for phase-wise safe development of mining benches. Waste minimization, mineral conservation and judicious land use are the other benefits of efficient mine planning.

b. Pollution Control Measures-This includes installation and maintenance of dust extraction and dust suppression system in mining and processing operations.

c. Environmental Monitoring- Regular monitoring of environmental parameters, including that of performance of pollution control devices, is yet another feature of eco-friendly mining.

d. Optimization of Resources Utilization- This technology optimizes energy and process water utilization. The three 'R' concepts, namely Recover, Reduce and Recycle Wastes, must also form the part of resources optimization.

LAND-USE AND LAND-COVER

With the increasing demand for land, land use planning and land evaluation have become more important as people strive to make better use of the limited land resources. Land evaluation is the process of assessing land performance for specified purposes (Rossiter, 1996). Land suitability assessment, a typical analysis approach for land evaluation, is the process of determining the fitness of a given tract of land for a defined use (Steiner,
1991). It is an indispensable part of land evaluation in the process of land use decision-making.

Land suitability assessment can help planners to select appropriate areas for government activities, residential land use, industrial land use, waste disposal site, and so on. By taking the results of land suitability assessment into consideration properly, the planners and decision makers can plan the future land use planning properly and maximize benefits from the use of land resources.

In the beginning on 1980's, there was no conformity in the standards and methods used in land suitability assessment. Since land evaluation approaches differed from country to country, information exchange was rather difficult. In the past several decades, land suitability assessment has been adopted as an important part of land use planning in rural areas, urban areas, and the fringe of urban and rural areas.

The Indian Bureau of Mines (IBM) came into existence on the 1st March, 1948 as a consequence of the recommendations of the National Mineral Policy Conference. From a small beginning as a purely advisory body, the IBM has emerged into a premier National Organisation dealing with practically all aspects of the country’s mining and mineral industry; fulfilling the dual role of enforcing statutory provisions as well as engaging in various development activities. In fact IBM has completed over 55 years of its existence and dedicated service to the nation towards mineral conservation, systematic development of minerals, environment protection and welfare of mankind.

With the expansion of mining industry and gradual adoption of updated technology in large mines, the functions of IBM were reviewed in 1966 and thereafter in 1981. The responsibilities and activities of IBM are guided by a 12 point organizational charter laid down by the Government of India in 1981. A significant addition to its charter was made in 1987 when responsibility of approval of mining plans and mining schemes was
entrusted to IBM on behalf of the Central Government. The IBM’s role in updating the national inventory of mineral resources has further been stressed in the National Mineral Policy enunciated in March, 1993. The role of IBM in the protection of environment has also further been strengthened by the notification under Environment (Protection) Act 1986 and Environment (Protection) Rules 1986 as well as in the Mineral Conservation Development Rules, 1988.

Having regard to changing scenario in the mineral sector in the wake of liberalisation of policy, concern of environment protection and ensuring systematic and scientific mining, the mandate for IBM has been further revised in the year 2003 vide Resolution notified under Gazette of India No. 22.03.03 No 12 Part-I, Section I, Page 430, 431 (Hindi), 482, 483 (English) as indicated below:-

1. To promote systematic and scientific development of mineral resources of the country (both on-shore and off-shore).
2. To approve mining plans, schemes and mine closure plans having regard to conservation of minerals and protection of mines environment.
3. To collect, collate and maintain database on exploration, prospecting, mines and minerals and to bring out publications/bulletins highlighting the problems and prospects of mining industry.
4. To play a pro-active role in minimizing adverse impact of mining on environment by undertaking environmental assessment studies on regional basis.
5. To conduct suo moto techno-economic field studies in mining, geology, mineral processing and environmental aspects include analysis of ore and minerals and to promote R&D activities in these areas.
6. To provide technical consultancy services on promotional basis within the country and abroad in the field of mining, geology, mineral processing and environment.
7. To provide training to the scientific, technical and other cadres of the Department and persons from the mining industry and other agencies of human resource development.

8. To advise the Government on matters in regard to mineral industry, relating to environmental protection and pollution control, export & import policies, trade, mineral legislation, fiscal incentives and related matters.

9. To promote awareness about conservation, systematic and scientific development of mineral deposits and protection of environment including restoration, reclamation and rehabilitation of mined out areas through exhibitions and audiovisual media.

10. To promote and monitor community development activities in the mining areas.

11. To undertake any such other activity as may become necessary in the light of the developments in the field of geology, mining, mineral beneficiation and environment

LEGISLATIVE MEASURES FOR ENVIRONMENTAL PROTECTION DUE TO MINING AND MINERAL PROCESSING / ENVIRONMENTAL LEGISLATION IN INDIA

In the review of mineral policy and mining legislation carried out during the period 1985-1990 in most developing countries of the region with mineral endowments, the international mining companies showed increased interest in investing in mineral exploration. As a result, a significant volume of capital flowed into the region, particularly to China, India, Indonesia, Pakistan, the Philippines and Vietnam.

Management of mineral resources is responsible of the Central Govt. and the State Govt. in terms of Entry 54 of the Union List (List-I) and Entry 23 of the State List (list-II) of the Seventh Schedule of the Constitution of India.

Indian government is much concerned about the prevention and protection of healthy environment conditions. A number of acts and rules have been enacted by the government from time to time inter alia and with necessary
modification there in. Notification and guidelines are also being issued. Even our constitution obliges the state and the citizen to protect forest and wildlife and develop compassion towards all living beings.

Legislative control of environmental degradation caused by toxic metals and the protection of workers engaged in mining and processing of mineral ore involves following steps

- Laying down a set of rules based on the expert recommendation.
- Prescribing non offensive levels of air-borne pollutants in the working environment.
- Adopting the international conventions and recommendations concerning the prevention of occupational risks, and
- Observing the codes of practice and guidelines in preventions, medical supervision, and improvement of working environment.

State governments have adopted a number of acts passed by parliament. For effective enforcement of these Acts, state governments have formulated a number of rules for the guidance of enforcement agencies. Following are some important legislation that have been made to protect the environment and ecology of the country.

- Mines and Minerals (Regulation and Development) MMRD Act 1957 (major amendment in 1986 and 1994)
- The Mineral Concession Rules (MCR) 1960 (amendment upto September 1994)
- The water (Prevention and Control of Pollution) Act 1981 (amended 1987)
- The Environmental (Protection) 1986
- The Mineral Concession (Amendment) Rule 2002

The overall framework of environmental legislation in India is set by the National Conservation Strategy and Policy Statement on Environment and Development, issued by the Ministry of Environment and Forests (MoEF) (June 1992) which identifies the following steps in order to integrate environmental consideration into decision making at all levels:

- Prevent pollution at source
- Encourage, develop and apply the best available practicable technical solution.
- Ensure that the polluter pays for the pollution and control arrangements.
- Focus on protection of heavily polluted area and river stretches.
  Involve the public in decision making.

LANDUSE PATTERN OF RAJASTHAN

The various parts of the state present a variety of land use patterns which exhibit, to a large extent, the availability of soil and water resources in the area and the human endeavors to harness them. In the areas having greater concentration of population, the significance for agricultural cropping of the land increases and therefore, the net shown area in these districts is relatively high. On the other hand, in the districts where soil is less fertile, extensive farming is needed to feed even a smaller population, so that the net area shown again increases. The common nine-fold classification of land use has been generalized here into six broad groups: forest, land put to non-agricultural uses, permanent pastures, net sown area, fallow land (including current and other fallow lands) and cultivable wasteland (including barren and uncultivable land, and land under miscellaneous tree crops). Land use/land cover mapping of all districts of Rajasthan has been completed under a National Land use/Land cover project, coordinated by National Remote Sensing Agency, Hyderabad. This work was done on 1:50,000 scale district maps by two work centers, namely, State Remote sensing Application center, Jodhpur & Central Arid Zone Research Institute, Jodhpur. Data of different categories of land use/land cover has been compiled by National Remote Sensing Agency, Hyderabad.

In the western districts Jaisalmer, Bikaner and Barmer, the percentage of cultivable waste and fallow land is the highest on account of the stretch of sandy soils in these areas. The net sown area in these districts is much less than the other types of land uses. In the semi-arid zone and the sub humid parts of eastern Rajasthan, the net sown area is the highest on account of extensive agriculture and the growing demands of increasing population. However, in the mid-western districts of arid and the semi-arid
zone, mainly in Churu, Nagaur, Jodhpur, Pali and Jalor districts, the percentage of fallow land is also quite high for the reason that only rainfed crops are grown in this area. The percentage of cultivable waste and the land put to non-agricultural use is highest in part of Bhilwara, Chittauragarh, Udaipur, Kota and Baran districts, owing to their hilly terrain. The percentages of forest areas are noticeably high in Kherwara (Udaipur), Dungarpur, Banswara, Sirohi, Kota, Jhalawar, Baran and Sawai Madhopur districts. Forest areas, in general, are conspicuously absent in the entire western Rajasthan. Higher percentage of pasture land, which are often seasonal, exist in Barmer, Jodhpur, Jalor and Nagaur tehsils.

**Fig. 5.3: Land Use Pattern Map of Rajasthan**

(Source: Ground Water Atlas 1998)
Unfortunately, increasing commercial activities have led to industrial pollution, land abuse, erosion processes, land reclamation, over dumping. As a result, the town ecosystem has been transformed into a polluted town.

LAND USE PLANNING

LAND USE PLANNING PROCEDURE: Land use can be defined as “the human manipulation and alteration of the land” (Alison, 2001). Land uses include settlement, cultivation, pasture, rangeland, recreation, and so on. In recent years, limited land resources in some countries could not meet increasing demands for land. In many developing countries, the demand for land becomes more pressing every year due to factors such as technical charge, economic development and population increase. According to the guidelines published by FAO (1993), land use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options. The purpose of land use planning is “to select and put into practice those land uses that will meet the needs of the people best while safeguarding resources for the future” (FAO, 1993). Land use planning is applied to solve problems of conflicts between certain land use and sustainable environmental development.

Reasonable land use planning procedures are basic prerequisites for successful long-term land use development. Land use planning needs an integrated procedure to achieve this objective. The procedure of a relative comprehensive land use planning in “the Guidelines for Land Use Planning” (FAO, 1995) which includes land suitability assessment is illustrated in (Fig. No. 5.4). Each step represents a specific activity, or set of activities, where outputs provide information for subsequent steps.
CHALLENGES FOR CURRENT LAND USE PLANNING

Land use change is a growing problem confronting policy, planning and decision making at all levels. It links problems and opportunities in urban and metropolitan communities to the larger issues of economic growth and environmental quality (Skole, 2002). Land use change is the critical connection between economic, housing, policy, jobs, and environment and so on.

Land resources in some developing countries like India face pressures from continuing land degradation and increasing numbers of people. Sometimes the conflict between different kinds of land use is predictable, especially in developing countries, which can further intensify the imbalance between land use and human activities and the degradation of land resources (Cai, 2004). Urbanization, defined as urban population proportion of the total population, is growing rapidly and has impacted
significantly on spatial urban development, especially on urban land use (Yeh, 1997). Rapid urban population expansion and urban cover in the developing world has been discussed well in recent years (McDaniel and Alley, 2005). As both urban land and rural land are resources in need of effective planning because of their importance in social and economic development, people migrate from rural areas to urban centres for more working opportunity and income. The need for effective land use planning is one of the consequences of the rapid urban population expansion and urban cover. In metropolitan areas urban cover is also related to negative impacts of poverty and social inequities, while in rural areas it involves the irreversible loss of farms, rural livelihoods, and open space (Skole, 2002). Over the last two decades, along with economic growth throughout the world there has been considerable land use change and development in the suburban and rural fringe of many metropolitan areas (Meine and Zhang, 2005; Ryan and Hansel, 2004). The trend of farmland loss is particularly evident in rural and suburban communities outside major urban centers. Since social-economic conditions have changed greatly, urban and suburbs land development is now an emerging issue that needs to be addressed.

Effective land use planning is necessary in order to ensure the orderly growth and development of both urban and rural areas. The process of expansion to the suburban fringe reflects some new environmental and landscape problems. The overall decision-making process must incorporate the entire suite of factors, including transportation infrastructure, population growth and distribution, economic growth and distribution, location and quality of jobs, location of retail, commercial and residential development, land values which change and development, and changes in the landscape and environment (Skole, 2002). These factors need to be considered in their current form and consideration should be given to how they may change in the future.
LAND SUITABILITY ASSESSMENT

Land provides the basic physical environment for welfare of the human beings and other terrestrial life forms and is also an important source of wealth (Alison, 2001; Rossiter, 1996; Adger and Brown, 1994). In general, land suitability describes “the fitness of a given parcel of land for specific uses” (FAO, 1976). Land suitability assessment is a planning approach to avoid environmental conflicts by the segregation of competing land uses (Eastman et al., 1993). Initially, this tool was developed as a means of relating spatially independent factors within the environment and, consequently, provided a more holistic view of their interactions (Steiner et al., 2000).

Land suitability is determined by both the fitness of the land for a particular use and the values and interest of the stakeholders in a region (Steiner et al., 2000; Bojorquez-Tapia et al., 1999). The objective of land suitability assessment is “to assist decision makers in finding the most appropriate locations or pattern of locations for fulfilling the goals for the involved stakeholders” (Bojorquez-Tapia et al., 1999). Now, suitability assessment helps land managers make decisions and establish policies for the utilization of particular land areas. It is a strategic process directed at the evaluation of the natural resources, and the regulation of human activities in a region (Steiner, 1991). Suitability refers to a specifically defined usage or practice, such as suitability for mineral exploration, suitability for dumping site or for particular government building schemes. Suitability techniques are essential for informed strategic decision-making (Steiner et al., 2000; 1991). There are generally two kinds of land suitability assessment approaches. First, the qualitative approach is used to assess land potential at a broad scale or is employed as a preliminary method for more detailed investigation (Baja, 2002; Dent and Young, 1981). The results of qualitative classification are given in qualitative terms, such as highly suitable, moderately suitable, and not suitable. The qualitative factors could not use the numerical score to present. Second, the quantitative approach is using parametric techniques involving more
detailed land attributes which allow various statistic analyses to be performed (Baja, 2002; 2001). Recently, most studies combined the qualitative and quantitative approaches in the process of land suitability assessment. The compositive technology including expertise, mathematic model and GIS has been used in the land suitability assessment (Malczewski, 2004; Yang and Jia, 2002; Chen, 2002; Bydekerke et al., 1998).

The approach to land suitability assessments is similar in most case studies. In general, the assessment process is made up of three steps. The first step is selecting the influencing factors and grading the weights and relative values for the factors. The second step is incorporating the maps and database in GIS. The last step involves calculating the suitability score of each land parcel for the given use and making the land suitability map. The primary result of land suitability assessment is the land suitability maps of specific use that can have a substantial influence on designing the plan. A set of land use suitability maps will be very helpful for land use planners and land managers to make complex decisions when they must take into account sustainable development and economic competitiveness (Joerin et al., 2001). Another result of land suitability assessment is the description of major land use types relevant to the area. Land suitability assessment also provides the relevant management and improvement specification for each land utilization type with respect to each land mapping unit for which it is suitable. The information on the reliability of the suitability estimates which is directly relevant to planning decision is given as the result of land suitability assessment. It also includes the subsequent work directed towards improving the land suitability classification, by indicating weaknesses in the data and aspects which might require further investigation (FAO, 1993; FAO, 1976). Another commonly purpose for using land suitability information in land use planning design is to select the most suitable land to allocate with the pre-plan.

Land cover is described by the attributes of the earth's ground surface capture in the division of water, vegetation, desert and the immediate
subsurface, soil, topography, surface and ground water and it also comprise those formation created exclusively by human being such as mine disclosure and conclusion. On the other hand, land use is the intended employment of land management strategy placed on the land cover by human agents, or land managers to exploit the land cover and reflects human activities such as industrial zones, residential zones, agricultural fields, grazing, logging, and mining among many others (Zubair, 2006; Chrysoulakis et al., 2004). Land use change is defined to be any physical, biological or chemical change attributable to management, which may include conversion of grazing to cropping, change in fertilizer use, drainage improvements, installation and use of irrigation, plantations, building farm dams, pollution and land degradation, vegetation removal, changed fire regime, spread of weeds and exotic species, and conversion to non-agricultural uses (Quentin et al., 2006).

Land use and land cover changes may be grouped into two broad categories as conversion and modification. Conversion refers to changes from one cover or use type to another, while modification involves maintenance of the broad cover or use type in the face of changes in its attributes (Baulies and Szejwach, 1998). According to Lambin (2005) sustainable resource use refers to the use of environmental resources to produce goods and services in such a way that, over the long term, the natural resource base is not damaged so that future human needs can be met. One of the most significant global challenges in this century relates to management of the transformation of the earth’s surface occurring through changes in land use and land cover (Mustard et al., 2004, cited in Daniels et al., 2008).

Land use and land cover changes result from various natural and human factors within social, economic and political contexts. Hence, the local human activities expressing the drivers can be determined by measuring the rates and types of changes and analyzing other relevant sources of data like demographic profiles, household characteristics and policies related to land resources administration. However, one of the major
challenges in Land use and land cover change analysis is to link behavior of people to biophysical information in the appropriate spatial and temporal scales (Codjoe, 2007). But, it is argued that land use and land cover change trends can be easily accessed and linked to population data, if the unit of analysis is the national, regional, district or municipal level.

To achieve this, it is crucially important to consider multiple sources of information and to acquire temporal, spatial and other non-spatial forms of data. This is due to the fact that land use attributes are complex and the boundaries between different types of data are quite diffuse (Baulies and Szejwach, 1998). Land use and land cover studies have been designed to improve understanding of the human and biophysical forces that shape land use and land cover change. Thus, linking human behavior and social structures to biophysical attributes of the land is a fundamental aspect of land use and land cover research (Baulies and Szejwach, 1998). Land use and land cover plays an important role in global environmental change and sustainability, including response to climate change, effects on ecosystem structure and function, species and genetic diversity, water and energy balance, and agro-ecological potential (Codjoe, 2007).

Land use and land cover mapping is one of the most important and typical applications of remote sensing data (Chrysoulakis et al., 2004). Remotely sensed data are a useful tool and have scientific value for the study of human environment interactions, especially land use and land cover changes (Dale et al., 1993 cited in Codjoe, 2007).

Along with the development of computer technologies, Geographic Information System (GIS) developed rapidly in the past twenty years. Since the 1990s, GIS have been applied to land suitability assessment for managing spatial data and presenting visual results. The issue of land suitability assessment will be examined in this thesis with particular reference to the Kishangarh area in Ajmer District. Kishangarh is the biggest market for marble cutting and selling all over the India as well as in other countries.
The Kishangarh area, which is located in the Ajmer district, has experienced rapid economic development. With this rapid development, the conflict with urban spread out of future development and land use is more obvious when considered in light of sustainable environmental development. As a result of lacking proper planning, some industrial factories and dumping ground are built on the vegetation land or on some mineral depository or on green land which has eventually caused more pollution or loss in any other ways. The pollution of Kishangarh has restricted the sustainable development of the entire tehsil area. This research focuses on the sustainable and rational use of land resource in the Kishangarh area. The thesis introduces land suitability assessment, land use planning, and geographic information systems and explores their inter-relationships.