Chapter 1

INTRODUCTION

Ecology suffers at the altar of economy as mining is essentially a destructive development activity. Unfortunately, the underground geological resources (minerals) are superimposed by above ground biological resources (forests) in most regions of earth. Hence, deforestation, habitat destruction, loss of biodiversity and erosion are necessarily involved with mining operations leading to degradation of environment and associated socio-economic problems.

Chauhan, 2010

Sustainable development is a buzz word in development of natural resources these days. The accent on sustainable development has grown in recent times, particularly in respect of those activities which affect both the environment and communities. Mining is one of such activities earliest known to mankind for mineral exploration. The use of minerals both in terms of quantity and variety has increased manifold in order to meet a wide range of demands of society with time. The present day society is crucially dependent on the minerals for sustained economic growth to alleviate poverty and improve the standard of living, especially in emerging economies like India and China (Planning Commission GOI, 2012). In the minerals sector, sustainable development means that investments in such projects should be financially profitable, technically appropriate, environmentally sound and socially responsible. In these circumstances, sustainable mining for mineral development is necessary to maintain a balance between economic, social and environmental well-being for present and the better future. Environmental management, good governance, economic and social stability and intra-generational and inter-generational equity are the challenges that India faces today for the development of its mineral sector for achieving a dynamic balance between supply and demand for minerals.

Mining in India dates back to 400 B.C. According to Kautiliya’s Arthashastra “Mines are the source of treasury, from which comes the power of the Government and the Earth”. It is the second largest industry after agriculture and has played a vital role in the development of civilizations from time immemorial. Man has caused severe degradation of his environment, by mismanaging both the renewable and non-
renewable resources all the way through his development (Ravichandran et al., 2009). Humans use renewable and non-renewable resources in day to day life but careful planning in using especially non-renewable resources is must otherwise they will vanish (Kumar, 2013).

Minerals are indispensable components of any nation’s economy. Due to overexploitation of these mineral resources in unplanned and unscientific manner results in severe environmental degradation. From the last two centuries or even more, the anthropogenic influence on environment has increased manifold due to the rapid growth in population and to fulfill its ever increasing demands. Environment has always been critical to life but concerns over the balance between human life and the environment assumed international dimensions from last few decades. The mining sector is to face a critical situation in future – measuring up to the challenges of economic liberalization, and at the same time, not to pose threat to ecological integrity of the nation. A general consensus is required to be achieved among the stakeholders, policy makers, and regulators for the planned and scientific development to protect the environment for future. Therefore, it necessitates studying and analyzing the impact of mining environs as per the guidelines of Ministry of Environment and Forest, Govt. of India (Ranade, 2007).

1.1 GROWTH OF MINING INDUSTRY IN INDIA

Number of mines has not changed substantially over the years. During 2010-11, total number of mines were 2928, out of which, 573 were fuel mines, 687 and 1668 mines were for extraction of metallic and non-metallic minerals respectively (Statistical Abstract, 2013). Three minerals viz coal (560 mines – 19% of total number), limestone (553 mines - 19% of total number) and iron ore (316 mines – 11% of total number) comprised about half of the total number of reported mines, thus signifying their demand and importance. Both open cast mining and underground mining operations are carried out and drilling/pumping is undertaken for extracting liquid or gaseous fuels. Our country produces and works with roughly 100 minerals, which are an important source for earning foreign exchange as well as satisfying domestic needs.

After achieving an average growth rate of 4.8% over the 5 years between 2006-07 and 2010-11, the mining sector has witnessed negative growth of 0.6% for two
consecutive years now (2011-12 and 2012-13), may be due to policy paralysis on a whole gamut of issues, irrespective whether they were in the domain of the Centre or of the States (FICCI, 2013).

State wise analysis revealed that during the year 2010-11, the value of mineral production in most of the mineral producing states have shown a mixed trend as compared to that in the previous year. The states which have indicated an increase in the value of mineral production over previous year are Chhattisgarh (41.94%), Himachal Pradesh (41.81%), Bihar (32.77%), Odisha (31.64%), Karnataka (26.20%), Uttar Pradesh (9.95%) and Tripura (8.36%). However, some of the principal mineral producing states revealed decrease in value of mineral production compared to previous year. Some of those are Jammu and Kashmir (33.67%), Kerala (11.25%), Arunachal Pradesh (7.19%), Andhra Pradesh (6.52%), West Bengal (6.35%), Maharashtra (2.82%) and Assam (1.42%) (Anonymous, 2013).

The country produced 84 minerals (excluding atomic minerals) in 2010-11, valued at 2, 00,609 crore (Anonymous, 2011). This is about twelve per cent increase from the value of minerals produced in the country in 2009-10 at 1, 79,384 crore (Fig. 1.1a). Fuel minerals contributed 68 per cent of the total value of minerals produced followed by metallic minerals i.e. about 21 per cent (Fig. 1.1b).

![Fig. 1.1(a) Value of Mineral Production in India](Source: Anonymous, 2011)

![Fig. 1.1(b) Contribution of Minerals to Value](Source: Anonymous, 2011)
Mining is one of the core sectors that drive growth in an economy. Not only does it contribute to GDP (Gross Domestic Product), it also acts as a catalyst for the growth of other core industries like power, steel, cement, which, in turn, are critical for the overall development of the economy. According to Federation of Indian Chambers of Commerce and Industry (FICCI) every one percent increment in the growth rate of mining and quarrying results in 1.2 – 1.4% increment in the growth rate of industrial production and correspondingly, an approximate increment of 0.3 percent in the growth rate of India’s GDP. Mining and quarrying sector accounted for 2.26 per cent of the total Gross Domestic Product (GDP) (at constant prices) in 2010-11 at 1,10,482 crore. Its contribution the previous year stood at 2.5 per cent with 1, 09,182 crore. The contribution of the sector to GDP has stood at about 2.2-2.5 per cent in the last decade (Bhushan et al., 2008).

India was ranked 4th amongst the mineral producer countries of the world, on the basis of volume of production, after China, United States of America and Russia (Report on Mineral Production, 2009). However, it had 8th position on the basis of value of mineral production during 2009. The royalty collected from non-coal minerals in the country was 4,470 crores in 2010-11. Iron ore and limestone accounted for 41 per cent and 30 per cent of the royalty collected, respectively (Fig. 1.2).

(Source: Anonymous, 2011)

Fig. 1.2 Mineral Wise Royalty from Different Minerals in India
Limestone is one of India’s most important mineral because of its use in cement, chemical, sugar, paper, iron and steel, fertilizer, textile and ceramic industries. The dimensional limestone is used for building and ornamental stone purposes. The size of its mines has witnessed a growth in last few decades. The production of limestone in 2010-11 was about 2,37,774 million tonnes as compared to that of the previous year, 2009-10 where it was 2,32,950 million tonnes (increased by 2%) owing to its more demand in the market. About 95% of the total production of limestone during 2010-11 was of cement grade, 3% was of iron and steel grade and the rest 2% consisted of chemical and other grades (Indian Minerals Yearbook, 2011). Figure 1.3 clearly depicts the rising trend of limestone production from year 2001-02 to 2010-11.

Figure 1.3 clearly depicts the rising trend of limestone production from year 2001-02 to 2010-11. 

(Source: Indian Minerals Yearbook, 2011)

Fig. 1.3 Production of Limestone from 2001-02 to 2010-11

India has huge resources of limestone distributed over different parts of the country. India is comfortably placed in the world in annual capacity and production of cement. Andhra Pradesh was the leading producing state accounting for 22% of the total production of limestone, followed by Rajasthan (18%), Madhya Pradesh (13%), Gujarat (9%), Tamil Nadu, Chhattisgarh and Karnataka (8%), Himachal Pradesh (5%), Maharashtra (4%) and the remaining 5% was contributed by Odisha, Uttar Pradesh, Jharkhand, Meghalaya, Bihar, Kerala, Assam and Jammu and Kashmir. With the increase in production, employment has also grown phenomenally. The average daily employment in the mining industry at present is about one million (Padhi, 2003).
Cement-grade limestone occurs in all the limestone-bearing areas, while Steel Melting Shop (SMS), Blast Furnace (BF) and chemical-grade limestone occur in selective areas. Increase in steel production in the country has escalated the demand for SMS and BF grade limestone. Concerted efforts to locate SMS and BF grade limestone along with cement-grade limestone are imperative to meet the growing demand. As per the Report of the Working Group, Planning Commission of India, the total limestone requirement during 12th Plan (2012-2017) with growth scenario of cement will be 10%, 11% and 12% for the respective GDP growth of 8%, 9% and 10% is projected at 3,163 million tonnes, 3,253 million tonnes and 3,385 million tonnes, respectively (*Indian Minerals Yearbook, 2011*).

### 1.2 GENERAL DESCRIPTION OF THE STUDY AREA

District Solan lies between North latitude 30°44’53” to 31°22’01” and East longitude 76°36’10” to 77°15’14” and is covered by Survey of India topo-sheets 53A, 53B, 53E and 53F. The average elevation of the district ranges between 300-3000 m above mean sea level (amsl). The district Solan is bordered by Simla district in the north and Ropar district of Punjab and Panchkula district of Haryana in the south, Sirmour district in the east and Bilaspur district in the west. Mandi touches the boundary in the north east (Fig. 1.4). Administratively, Solan town is the head quarter of the district.

The district is divided into four sub divisions:

1. Solan – Solan and Kasauli tehsils
2. Nalagarh - Nalagarh tehsil, Ramshehr and Krishangarh sub tehsils
3. Arki – Arki tehsil
4. Kandaghat – Kandaghat tehsil

The Mining Lease area taken as a case study for present research work, **Ambuja Cement Ltd.** (ACL), comprises a total area of about 488.06 ha falling in Kashlog, Chakru, Serwala, Banjan, Pati, Banli, Banog, Rathoh, Mangu, Chola, Ghamaru, Serjeri, Gyana, Rauri, Sangoi villages of Tehsil Arki in Solan District of Himachal Pradesh (Table 1.1). ACL contributes about 10 percent of total cement production of India. Geographically, the study area falls between latitudes 31°3’50.5” to 31° 15’28”
North and longitude 76° 55’38.5” to 77° 9.5” East with elevations in the range of 1280 to 1740 m amsl (Fig. 1.4).

**Table 1.1: Details of Mine Lease Area**

<table>
<thead>
<tr>
<th>District/State</th>
<th>Tehsil</th>
<th>Villages Covered</th>
<th>Area</th>
<th>Date of Expiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solan, HP</td>
<td>Arki</td>
<td>Kashlog, Chakru, Serwala, Banjan, Pati, Banli, Badog, Banog, Ratoh, Mangu, Chola, Gamaru, Serjeri, Gyana, Rauri, Sangoi</td>
<td>488.06 Hectares</td>
<td>Twenty years from 28.05.92 to 27.05.2012</td>
</tr>
</tbody>
</table>

(Source: Anonymous, 2012)

The National Highway, NH-88 connecting Simla to Bilaspur, passes about 4 km south of the mine. The aerial distance between cement plant and the mine is 2.8 km while the road distance is 19 km. The nearest railway station is at Simla, which has a narrow gauge rail line from Kalka. Simla, the capital city of Himachal Pradesh is 45 km road distance from Darlaghat. Kashlog mine is 109 km from Kiratpur Sahib Railway Station via Swarghat, Nauni, Darlaghat and Kararaghat off NH 88, and from there partly metalled and partly unmetalled road links Kashlog over a distance of 10 km.

The mining lease area includes mining area, site office and other establishments.

The lease for mining limestone from the area under study was granted for twenty years from 28.05.92 to 27.05.2012. Renewal of Kashlog limestone mine lease of ACL was due on 27-05-2012. ACL applied to State Government for renewal of lease vide letter dated 24-01-2011. Geology Wing of Department of Industries, Government of Himachal Pradesh vide letter no. Udyog-Bhu (Khani-4) Major-289/2011-2089 dated 07-06-2012 approved the renewal of mining lease for extraction of limestone and shale for captive use in existing cement plants for a period of next 20 years.

ACL’s existing cement plant in Himachal Pradesh is located at Suli, tehsil Arki in district Solan. The clinkerization capacity of Suli plant is 2.6 Million Tonnes Per Annum (MTPA). ACL has obtained the environmental clearance for 5.5 MTPA limestone mining at Kashlog, Patti and Mangu villages, located in the Arki tehsil.
Another plant located at village Rauri is also under operation. ACL is expanding the capacity of the mineral extraction from 5.5 MTPA to 7.6 MTPA, so as to cater to the demand of both Suli and Rauri plants.

![Fig. 1.4 Location Map of the Study Area](image)

The lower sub-Himalayan area around Kashlog, is basically hilly, the cultivated area is negligible, only few farms on the flanks of the hills have been created by terracing. Most of the high rising hills surrounding Kashlog limestone ridge bear the Chir plantations. The intervening valleys are inhabited. Most of the streams flowing through the valley are seasonal. The origin is young and the hill ranges are severely affected by denudation agencies like snow in the northeastern parts and by rivers and streams in the rest of the area.

The temperature of the area fluctuates from $4^\circ\text{C}$ to $34^\circ\text{C}$ for winter season to summer season. The area receives the mean annual rainfall of 1450 mm with average of 64 rainy days. The district is surrounded by catchment area of three rivers Satluj, Yamuna and Ghaggar. Soil is generally sandy loam in valley areas of the district and in rest of the hilly and mountainous areas soil is skeletal. Soil depth is generally shallow except in areas having good vegetative cover.
1.3 STATEMENT OF THE PROBLEM

Sustainable mining is that which is financially viable; environmentally, technically and scientifically sound; socially responsible; with a long term view of development; uses mineral resources optimally; and ensures sustainable post-closure land uses; also one based on creating long-term, genuine, mutually beneficial partnerships between government, communities and miners, based on integrity, cooperation and transparency. This study was undertaken to identify, quantify and evaluate the cumulative impact of various operations of limestone mining on environmental attributes like geology, soil quality, air quality, water quality, noise levels, ecology, demography and socioeconomics in the Kashlog and surrounding limestone mining areas of Solan district, Himachal Pradesh. Since mining is next to none but agriculture, it plays a vital role in economy and upliftment of a country and moreover, clock of progress and exponential growth of industrial society cannot be set without this.

In order to ensure that human activities lead to a balanced and sustained development with little or no impact on the environment, for this regular monitoring of the environmental changes is required. Once the changes and causes of changes are understood, remedial measures can be suggested and implemented. True development always strikes judicious balance between immediate and long-term requirements. Development is hardly sustained when the natural resources like minerals, water, soil and vegetation – the basic economic capitals are depleted.

The ever increasing scales of mining have been resulting in intense conflicts between mines and their external environment - social, physical and biological. The cement producing plants and their captive mines often bring about a series of changes of temporary as well as irreversible nature which if not arrested through appropriate mitigation measures may even cause irreversible damage to the ecosystem. There has to be proper evaluation of all aspects of environmental degradation caused by mining and related development activities. In view of the above, ‘Geo-environmental Assessment of Impacts of Limestone Mining in parts of District Solan, Himachal Pradesh, India’ was undertaken.

The process of prediction of environmental impact was based on straightforward approach of relating sources of stress to environmental receptors identified in the
The key characteristics of the project and the ecosystem components considered in the environmental impact assessment are presented in the following Table 1.2.

**Table 1.2: Potential Environmental Impacts of Mining**

<table>
<thead>
<tr>
<th>Impact Receptors</th>
<th>Nature of Impacts (Positive and Adverse)</th>
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| Human environment      | ➢ increased direct and induced employment opportunities, income and wealth  
                         ➢ increased wealth  
                         ➢ increased goods and services  
                         ➢ improved access, particularly to previously inaccessible areas  
                         ➢ conflicts with existing land uses and displacement of existing uses  
                         ➢ subsidence risk to local farmers and to rural livelihoods and cultures  
                         ➢ damage to cultural sites  
                         ➢ increased demands on services and facilities, social and cultural conflicts, community instability  
                         ➢ 'boom bust' economic, social and cultural conflicts and displacement of local populations  
                         ➢ road damage, traffic delays, health and accident risks  
                         ➢ secondary developments                                                                                                                                                                                                             |
| Natural environment    | ➢ removal and transfer of large amounts of rock and soil and its deposition as spoil elsewhere  
                         ➢ total disruption and modification of landscapes  
                         ➢ changes, possibly irrevocable, to underground and surface drainage  
                         ➢ loss of existing land uses  
                         ➢ loss or burial of vegetation and farm land under mine spoil  
                         ➢ damage to wetlands and coastal areas  
                         ➢ use of stream banks and shorelines for waste disposal and ancillary facilities  
                         ➢ disruption, blockage and re-routing of stream channels and creation of residual ponds |
| Land | ➢ reduced reproduction and populations of wildlife due to habitat modification and loss (e.g. breeding grounds, nurseries) and indirect disturbances from noise and fumes  
➢ Increased wildlife mortality from road traffic and surface disturbance  
➢ degradation of vegetation (and soil) from flooding of contaminated water courses  
➢ modification of vegetation and introduction of non-native species  
➢ loss of birds and animals due to contamination from tailing and leach ponds  
➢ denuding of vegetation due to toxicity |
| Water | ➢ stream siltation and other forms of degradation of surface water by soil erosion from disturbed areas, waste piles and stock piles  
➢ downstream water quality impairment and damage to aquatic flora and fauna  
➢ contamination of surface water and groundwater  
➢ disruption/blockage of surface water, intensifying local flooding problems and affecting aquatic ecology including fisheries  
➢ deepening of stream channels  
➢ reductions in local water supplies |
| Soil | ➢ contamination of surface areas with mineralized/toxic rock material (e.g. deposition of mining wastes) |
| Air | ➢ degradation of air quality and visibility from airborne particulate resulting from blasting, excavation, earth moving, transportation and material transfer operation |
Concept of scientific mining basically revolves around three parameters.

1. Starting mining from top to bottom by making approach road of proper gradient (i.e.: 1:12 to 1:16).

2. Keeping angle of repose as 45°. This ensures making benches of 6 m height and 6 m width.

3. Proper disposal and utilization of debris, undersize material and soil generated (if any). Soil generated should be used for afforestation along worked out benches. Garland parapet all around the mineral to be excavated, settling tank are suggested to be constructed during Pre-production stage.

The working of the mines should be in accordance with the approved Mining Plan-cum- Environment Management Plan. It is extremely difficult in most developing countries like India, with weak policies, low awareness, poor knowledge and limited financial resources to support sustainable development. Even if there are global or regional laws on involuntary resettlement, the question for researchers is how to adapt these laws to the local context and find the way and the extent to apply them in practice.

1.4 ENVIRONMENT IMPACT ASSESSMENT (EIA)

EIA is a formal process for identifying the likely effects of particular activities or projects on the environment, human health and welfare. EIA also encompasses the development of mitigation measures to address these impacts and suggested approaches for implementation of mitigation and monitoring measures. EIA is not to be regarded as an academic exercise as this has to ensure that environmental values and factors have to be integrated into the decision-making process. EIA conveys information about environmental effects of a project to decision makers at a stage when such information can materially affect the output.

EIA is an assessment of the possible impact positive or negative-that a proposed project may have on the environment, together consisting of the natural, social and economic aspects. Its purpose is to identify, examine, assess and evaluate the likely and probable impacts of a proposed project on the environment and, thereby, to work out remedial action plans to minimize adverse impact on the environment. It is an
important management tool for ensuring the justified use of natural resources during developmental process (EIA Notification, 2006).

1.4.1 Environmental Impact Assessment Notification, 2006

The Environment Impact Assessment Notification which was notified on 14th September, 2006 supersedes the 1994 EIA Notification. The purpose of the notification is to impose certain restrictions and prohibitions on new projects and activities, or on the expansion or modernization of existing projects and activities based on their potential environmental impacts. A prior environmental clearance must be obtained either from the Central Government or the State/ Union Territory Level Environment Impact Assessment Authority, constituted by the Central Government under the Environment Protection Act, 1986.

According to the notification, different projects/developmental activities have been divided into 8 major heads requiring “Environmental Clearance” (EC) either from Central Government, i.e. MoEF (Category ‘A’) or at State Level from State Environmental Impact Assessment Authority (SEIAA) (Category ‘B’). The category ‘B’ has been further divided into category ‘B1’ project which requires submitting EIA report and ‘B2’ project activities which don’t require EIA report. All categories ‘A’ and ‘B1’ projects necessarily have to carry out EIA studies along with the “Public Hearing” as per the procedure stipulated in the notification. In the draft notification (January, 19th 2009), revised “threshold criteria” have been introduced for different project categories. Further, an effort has also been made to make EIA procedure more transparent and to provide societal vigil of projects affecting the environment through “Public Hearing/ Consultation” by moving the environment protection agenda into public domain.

1.4.2 Common Stages in EIA Process

EIA is a process having the ultimate objective of providing decision-makers with an indication of the likely consequences of their actions (Wathern, 1988). The most important thing for the sustainability is that EIA process should be fair, objective, unbiased and balanced and should provide balanced, credible information for decision-making. It should result in environmental safeguards. A key weakness with the process is the lack of a seamless link between the EIA and the implementation
phase where environmental management systems, which include a management plan, monitoring, auditing as well as provisions for closure, are required.

Although the EIA process varies from country to country, there are certain basic steps that are common to all. Figure 1.5 shows the process involved in EIA in which each step has an equal importance in determining the overall performance of the project.

As per the new EIA Notification dated 14 September, 2006, the mining project falls under category ‘A’, project activity 1(a) (3). Therefore, this project requires Environmental Clearance from MoEF, New Delhi. This EIA was carried out for the Kashlog Limestone Mine owned by ACL, located at Darlaghat in Solan district of Himachal Pradesh, which is quarrying the lime stone from the year 1990 to till date and has got the approval to mine up to the year 2020 and may be renewed in future. Therefore, this thesis attempts to assess the rapid environmental impacts of limestone mining and the preparation of Disaster Management Plan for this limestone mine.

![Flowchart Showing the Common EIA Process for any Developmental Activity](image-url)
1.5 REVIEW OF LITERATURE

The environmental parameters likely to be affected by mining are related to many factors, i.e., physical, social, economic, agriculture and aesthetic. A lot of research work and surveys have been conducted in this field by various scholars. The review of this literature provides background for the research topic using previous research. It also helps to establish the validity of a research project by revealing gaps in the existing literature on a topic that offer opportunities for new research. Following are the International and National studies by the various researchers in the field of mining and related environmental problems.

1.5.1 International

❖ Mulwa et al. (2012) carried out multi-elemental analysis of limestone and soil samples of Kitui South (Kenya) limestone deposits. The major elements detected in soil were Ti, Mn, Cu, Zn, and Pb, while in limestone Ti Mn and Zn were found.

❖ Adewole et al. (2011) studied the impact of marble mining on soil properties in a part of guinea savanna zone of southwestern Nigeria. They concluded that there was a need for close monitoring of marble mining activities in Nigeria as deposit of marble particulates may result to soil nutrients’ imbalance and hence poor soil health especially in areas polluted with marble particulates will be encountered.

❖ Hydro-chemical impact of shallow limestone rock industrial-scale mining activities close to sensitive constructed and natural wetlands were investigated by Naja et al. (2011). According to them the chemical composition of sulfate and chloride in groundwater increased with depth. Comparatively, the surface water chemical composition in the surrounding areas showed much lower cationic and anionic charge.

❖ Gopalkrushna (2011) determined the physico-chemical parameters of surface water samples in and around Akot city. Results of his study revealed that all the parameters for water samples were above the permissible limit and the quality of water was very poor. Hence, the water is unfit for drinking and domestic purpose.
Groundwater quality and its suitability for drinking and agricultural use in Ain Azel plain, Algeria was studied by Belkhiri et al. (2010). They found that the groundwater of Ain Azel plain was with low concentration of nitrogenous elements (NO$_3^-$ and NO$_2^-$) and the higher concentration of trace elements (Pb$^{++}$ and Fe$^{++}$) which may entail various health hazards.

Nefeslioglu et al. (2010) investigated the possible applications of decision tree in landslide susceptibility assessment. In their study, decision tree, one of the data mining methods was investigated to produce landslide susceptibility map of a landslide-prone area Cekmece, Istanbul, Turkey. The model was used to predict the landslide susceptibility degrees and the effect order of input attributes on landslide occurrence was investigated.

Adefemi and Awokunmi (2010) determined physico-chemical parameters and heavy metals in water samples from Itaogbolu area of Ondo-State, Nigeria. The results of various physico-chemical parameters and heavy metals analysis, obtained fell within the maximum allowable limit set by World Health Organization for drinking water except for water from Ona river.

Busuyi et al. (2008) studied assessment of the socio-economic impacts of quarrying and processing of limestone at Obajana, Nigeria. Their study revealed that the lifestyle of the people was still below the standard, the level of education within the community was poor and there was higher percentage of illiteracy level.

Iwanoff (1998) described the influence of three opencast limestone mines in North Germany on water economy and environment and concluded that salinization of the groundwater from below the mines, which was ascending due to relief of hydrostatic pressure, influenced the water quality of the receiving streams.

In South Jordan, a study of heavy metal distribution in soils around a cement factory in Qadissiya area showed relatively high concentration of lead, zinc and cadmium in soil samples of the investigated area was related to anthropogenic activities sources such as the cement industry, agricultural activities and traffic emissions (Al-Khashman and Shawabkeh, 2006).
1.5.2 National

- Lamare and Singh (2014) reported the impact of limestone mining on water quality based on analyses of various physico-chemical parameters of water samples of the Mining area in East Jaintia Hills and its comparison with the results of unaffected water body. The study revealed that open cast mining of limestone rock’s and direct contact of wastewater from the cement plants into the water bodies does have a negative impact on the physico-chemical characteristics of the waters of the area.

- Ayyandurai et al. (2013) studied evaluation of groundwater for irrigational purposes in Cumbum valley Theni district Tamilnadu India. As per Doneen’s and Wilcox classification majority of groundwater samples were of good to permissible category and fell under Class-I. Whereas, according to the SAR values, most of the groundwater samples belong to C3-S1 (41.82%) class indicating high salinity and low sodium water, which can be used for almost all types of soil with little danger of exchangeable sodium.

- Lata (2013) studied Geo-Environmental Impact Assessment: A Study of Sorang Hydroelectric Power Project (SHEP) in District Kinnaur, Himachal Pradesh, India. According to her people living near the project area were facing greater problems of deforestation, erosion, loss of land, compensation and different water borne diseases as compared to people living in the far regions due to construction of SHEP.

- Sharma et al. (2013) carried out physico chemical analysis of soils in the surroundings of Kashlog limestone mining area. It was concluded that the land-use pattern has changed due to the use of the land for mining, dumping, and other mining and associated activities. Continuous mining activities had damaged the land and the soil samples evaluated in the study were found partially safe for plantation, vegetation and agricultural purposes.

- Sahu et al. (2011) found that the impact of mining activities on pollution of air, water, land, soil quality, vegetation including forest ecosystems, human health and habitation has become a matter of serious concern, while investigating degradation due to mining in India and its mitigation measures.
Sood and Bhimta (2011) studied effective land utilization for rehabilitation of a fragile limestone mining zone at Darlaghat, district Solan, Himachal Pradesh. They highlighted the concerted efforts made by the mining managers in consonance with the Forest Department to attain the objectives achieving fruitful results within a short span of time.

Singh et al. (2010) carried out the assessment of environmental impacts by mining activities in Jhansi, Uttar Pradesh, India. They concluded that mining activities are unsustainable not only because they exploit non-renewable resources, but also because they leave behind them destruction of the environment and society, which is very often irreversible. Because of its impacts, mining is one of those activities that need to be strictly controlled at all stages, from prospection and exploitation to transportation, processing and consumption.

Chauhan (2010) studied the link of mining, development and environment in Bijolia mining area of Rajasthan, India. His study emphasised on scientific mining operations accompanied by ecological restoration and regeneration of mined wastelands as also the judicious use of geological resources.

Singh (2008) while studying mitigation of environmental and social impacts of coal mining in India observed that coal mining affects the environment through land degradation, deforestation, pollution of surface and groundwater regimes, air pollution, noise, vibration and its effect on plants and wild life.

Sanjeevi (2008) studied targeting limestone and bauxite deposits in southern India by spectral unmixing of hyper-spectral image data. It was revealed that linear spectral unmixing method adopted to quantify CaCO₃ in limestone has given fairly good results. It also helped in generation of the alumina abundance image which was used to demarcate bauxite rich zones.

Singh (2008) studied geological aspects of environmental degradation in parts of Sirmaur district, Himachal Pradesh, India. He observed that water and air quality had deteriorated in and around mining zones due to unscientific methods of mineral extraction. Mining had also reduced greenery from hillocks considerably. The direct damage to closed forests on account of
mining activity may be less but illegal exploitation, illicit felling, leasing in close forests, forest fires, human interference, grazing and encroachment to these forests had resulted in serious imbalance in study area.

- Ahmed et al. (2007) carried out evaluation, planning and management of water resource in and around a limestone mining area located at Madhya Pradesh. Their results based on geochemical analysis revealed that the groundwater from the study area was potable.

- Remote sensing techniques can play a major role in carrying out the environmental studies and the subsequent impact assessment especially for opencast mines, which are of dynamic nature. Environment Impact Assessment of land use planning around Chittorgarh limestone mine was reported by Ranade (2007) using remote sensing technique.

- Vegetal profile of natural plant succession and artificially revegetated limestone mines of Himachal Pradesh, India was studied by Hanief et al. (2007). Study carried out in Sal forest of Sirmaur district of Himachal Pradesh revealed that the artificially reclaimed sites develop much faster in terms of soil and vegetation as compared to abandoned mines.

- Ghose (2004) studied restoration and revegetation strategies for degraded mine land for sustainable mine closure. The study revealed that soils show a continuous decrease in quality, and ultimately become biologically sterile with time. They also concluded that biological reclamation is essential if the soil is to be stored beyond the shelf-life period.

- The air and water pollution aspects of limestone and dolomite mines on the nearby locality have been investigated by Mishra et al. (2004). It was observed that the common parameters of air and water were within the prescribed limits. However, number of people in this area were found affected by tuberculosis, which may be due to prolonged exposure to dust in the mines.

- Vaghofikar (2003) studied the impact of mining on ecologically sensitive areas and found that mining activities were destroying some of the most ecologically sensitive areas, including catchments, wildlife sanctuaries, national parks and tribal communities.
Ghose (2003) studied Indian small scale mining with special emphasis on environmental management and observed that such mining caused negative impacts on the environment due to poor handling of resources.

Development and environment are two sides of a coin. Khitoliya (2002) studied Environmental Impact Assessment and sustainable development and considered pinpointing and qualifying the various factors which directly or indirectly lend their hand to the effects on environment.

Present status of asbestos mining and related health problems was studied by Ramanathan and Subramanian (2001). It was reported that the direct and indirect employment in asbestos mines (around 100,000 workers) causes clinical effects like fibrosis, sequelae, bronchogenic cancer, malignant mesothelima and cancer risk.

There also exists a substantial literature reporting the results of empirical and theoretical research. Perceived deficiency in the theoretical literature was identified and existing body of theory was reviewed to highlight the need for further attention to be paid to the EIA/Management relationship (Bailey, 1997).

Ambulkar et al. (1994) carried out multi-elemental analysis of ambient air dust particulates from a cement factory by neutron activation. Wide differences have been observed in elemental concentrations of As, Br, Co, Cr, Fe, Se and Mn in dust particulates collected from different locations depending on its distance from the factory.

The trend of coal production and the related methane emission to the atmosphere from the mining activities in India was studied and presented by Banerjee et al. (1994). They stated that the estimates of emission have been found to increase from 0.06 million tonnes to 0.40 million tonnes between the year 1951 and 1991 and may further rise to 0.60 million by the turn of the century.

Katila (1994) studied continuous air pollution monitors, a pre-requisite to efficient control. Their study revealed that at the time of designing of pollution control system for the same plant, the aspect of monitoring the quality of
residual waste output was not given the attention it deserves, whereby the whole purpose of installing such a system was defeated.

- Metrose: a modified windrose for air quality management was studied by Niyogi et al. (1994). According to them metrose was particularly more advantageous for applications in modelling and spatial planning and is more explicit than a windrose.

- Diurnal and seasonal variations in air pollutant concentrations in a seasonally dry tropical urban environment were studied by Pandey and Agrawal (1994). According to them the logarithmic normal distribution pattern of 2-h mean concentrations of $\text{SO}_2$, $\text{NO}_2$, and $\text{O}_3$. Ozone concentrations peaked from late morning to afternoon of summer and those of $\text{SO}_2$ and $\text{NO}_2$ during early morning and late evening of winter months.

- A preliminary survey was conducted in February, 1992 to study the quality of ambient air at the Barsuan mines by Samantaray et al. (1993). They concluded that there was no serious problem of air pollution in and around the Barsuan Iron Ore Mines, except for an occasional high concentration of suspended particulate matter.

- According to the study of Bagchi and Ghose (1978), the use of gunpowder for armament had been known but there is no evidence to suggest that how it found its way into mining. They further stated that there is clearly a need for more research into the state of the art of mining during the medieval ages for unearthing the traditions of the past through important mining centers (Copper, Lead, Zinc and Gold) of India.

After reviewing the literature available on the issue, going through field and laboratory investigations and the survey conducted in and around the study area, the aims and objectives of the research work were clearly stated.

1.6 AIMS AND OBJECTIVES OF THE STUDY

Mining is one of the necessary evils of the modern world. It provides the material required to sustain quality of life, but does immense, sometimes irreparable, damage to the environment. Opencast mining, the method of limestone extraction in the study
area, where ores are recovered from exposed areas, is particularly disruptive to both landscape and ecosystem. Waste materials or soil spoils that remain after the extraction of usable ores are unscientifically dumped on the surrounding land. These sites leave the land devoid of topsoil, nutrients and supportive micro flora and vegetation – in a word, barren. As mining activities spread, so does the damage, causing more and more disruption to the region's land, aquatic and atmospheric ecosystems. Over the short term, opencast mining can reduce forest yields; over the long term it can lead to dramatic changes in microclimates.

To research and analyze the impacts, both direct and indirect that the mining activity might have on the local environment and population in a study area was the aim of this study. Mainly the environmental impacts and socio-economic impacts were investigated. The intensity of the environment impact of mining depends on what is being mined and under which geo-environmental terrain. Extent of mining is to be meticulously planned and carefully executed. Mining can devastate lands, pollute and deplete water, denude forests, wipe out wildlife and defile the air. Unfortunately, the environmental performance of Indian mining industry has been quite poor. Furthermore, this was observed and explained that how these impacts are affecting the development of the local communities and their mitigation measures had also been worked out. Following are the specific objectives of present study:

- To collect the baseline status around the mining location for major environmental attributes.
- To identify, quantify and evaluate the cumulative impact of various mining operations on environmental attributes like geology, soil quality, air quality, water quality, noise levels, ecology, demography and socio-economics in the study area.
- To prepare a Disaster Management Plan including the safety measures to be adopted at limestone mines.
1.7 FORMAT OF PRESENTATION

As an output of this research a thesis of six chapters with some appendices had been prepared. The format of presentation is given below.

Chapter 1: Introduction

First chapter deals with the general introduction of mining industry, research problem, aims and objectives of the research and the literature review for the present work. The history and evolution of EIA and common stages in EIA process was also incorporated in the Chapter.

Chapter 2: Background of Mining Activity in Solan

This chapter gives a brief account of mining activity in Solan. It also gives a detailed description about the Kashlog limestone mines which includes its location, different blocks and method of mining. The geology and hydro-geological conditions of an area strongly influence the occurrence and distribution of groundwater as well as surface water. This chapter also provides a comprehensive account of geology, hydrogeology and rock and minerals of the area under investigation.

Chapter 3: The Physical Environment

This chapter describes the systematic approach to the research problem, which starts with a preliminary survey of the limestone mine, field investigation and laboratory methods employed to determine their base line environmental status. Studies were undertaken to generate baseline data within a 10 km radius around the project on land environment including changes in land use and land cover pattern and soil quality, ground and surface water quality, meteorology, ambient air quality, noise levels and forest cover.

Chapter 4: The Social Environment

This chapter focuses on the socio-economic impact of limestone mining including tool and techniques of data collection and case studies. Though mining activity in the region, has given a sudden boom to employment in the region, it has also brought some major social changes in the field of land acquisition, water shortage and natural
calamities, change in surrounding environment and health of workers as well as local people.

Chapter 5: Environmental Impacts and Their Mitigation Measures

This Chapter deals with the impacts of limestone mining during construction phase and operational phase of the project and the mitigation measures. Further, it discusses the Disaster Management Plan for the study area.

Chapter 6: Summary and Conclusions

This chapter embodies the summary of the observations and conclusions drawn from various laboratories and field investigations in the study area. In the present investigation, the author has attempted to provide a complete assessment of the prevailing environmental problems in the study area which falls in district Solan, Himachal Pradesh. Certain recommendations for further research are also the content of this chapter.