The tradition of mining in India is ancient and underwent modernization alongside the rest of the world as the country gained independence in 1947. The economic reforms of 1991 and the 1993 National Mining Policy further helped the growth of the mining sector. Khullar (2006) holds that mining in India depends on over 3100 mines, out of which over 550 are fuel mines, over 560 are mines for metals, and over 1970 are mines for extraction of nonmetals. The figure given by Padhi (2003) is about 600 coal mines, 35 oil projects and 6000 metalliferous mines of different sizes employing over one million persons on a daily average basis. Since time immemorial, India did mining of various minerals. Zinc mining on a commercial scale began at Zawar mines in Rajasthan centuries ahead of Europe. Rajasthan has the earliest dated lead-zinc mines in the world. India developed strong technology of mining and smelting, which is older than Harrapan civilization.

The oldest known mine on archaeological record is the "Lion Cave" in Swaziland, which radiocarbon dating show to be about 43,000 years old. At this site paleolithic humans mined mineral hematite, which is Iron oxide, was ground to produce the red pigment ochre. Mines of a similar age in Hungary are believed to be sites where Neanderthals may have mined flint for weapons and tools. Flint was known and exploited by the inhabitants of the Indus Valley Civilization by the 3rd millennium BCE. Biagi and Cremaschi (2008) of Milan University discovered a number of Harappan quarries in archaeological excavations dating between 1985-1986. Biagi describes the quarries: From the surface the quarries consisted of almost circular empty areas, representing the quarry–pits, filled with aeolian sand, blown from the Thar Desert dunes, and heaps of limestone block, deriving from the prehistoric mining activity. All around these structures flint workshops were noticed, represented by scatters of flint flakes and blades among which were typical Harappan-elongated blade cores and characteristic bullet cores with very narrow bladelet detachments. Between 1995 and 1998, Accelerator mass spectrometry radiocarbon dating of *Zyzyphus cf. nummularia* charcoal found in the quarries has yielded evidence that the activity continued into 1870-1800 BCE.

*De re metallica* (Latin for *On the Nature of Metals (Minerals)*) is a book authored by Georgius Agricola (1556) cataloguing the state of the art of mining, refining, and smelting metals. He explains that mining and prospecting are not just a
matter of luck and hard work; there is specialized knowledge that must be learned. A miner should have knowledge of philosophy, medicine, astronomy, surveying, arithmetic, architecture, drawing and law, though few are masters of the whole craft and most are specialists. This section is full of classical references and shows Agricola's classical education to its fullest. The arguments range from philosophical objections to gold and silver as being intrinsically worthless, to the danger of mining to its workers and its destruction of the areas in which it is carried out. He argues that without metals, no other activity such as architecture or agriculture are possible. The dangers to miners are dismissed; most deaths and injuries are caused by carelessness and other occupations are hazardous too. Clearing woods for fuel is advantageous as the land can be farmed. Mines tend to be in mountains and gloomy valleys with little economic value. The loss of food from the forests destroyed can be replaced by purchase from profits, and metals have been placed underground by God and man is right to extract and use them. Agricola further argues that mining is an honorable and profitable occupation. His other books deals with miner and a discourse on the finding of veins, Veins and stringers and seams in the rocks, Delimiting veins and the functions of mining officials, The digging of ore and the surveyor's art, The miners' tools and machines, On the assaying of ore, Roasting, crushing and washing ore, Methods of smelting ores, Separating silver from gold and lead from gold or silver, Separating silver from copper, Manufacturing salt, soda, alum, vitriol, sulphur, bitumen, and glass.

According to Rudra (2002), the mining and quarrying enterprises of industrial minerals and construction materials that occurs at subsistence level throughout India, that is, the operations producing relatively smaller quantities of mineral and employing relatively fewer persons, are termed as small mines. Sahu (1992) described the small mines as ‘those whose production, or excavation quantity is limited in tonnage and not very large, mostly manually operated and sometimes employing machines to small capacity. Such mining activities are usually confined to deposits which are shallow in depth and small in extent. The exact definition of mines as small, medium and large scale also differs from country to country, without any universal yardstick (Noetstaller, 1987).
Humphreys (2001) examined that adopting the values of sustainable development implies an increase in the mining industry’s environmental and social costs. For an industry already offering poor returns on capital this is potentially a problem. An examination of the historical record, however, reveals that past increases in environmental and social costs have been more than offset by developments in industry productivity. The emergence of information and communication technologies seems likely to extend this trend into the future. He opined that industry’s adoption of more sustainable practices will require, and could even promote, improved returns to capital in mining.

Naroma et al. (2008) tried to identify the environmental effects of quarrying specifically at a geologic perspective. They further tried to discover the socio-economic benefits provided to the residents of adjacent and nearby barangays within the provinces of Ilocos Sur, Ilocos Norte, La Union, and Pangasinan; and solicited their perceptions on the pressing effect(s) of the industry. They have identified four types of quarrying in Ilocos Sur, namely: clay extraction at Bulala, Vigan City; gravel quarrying at Banaoang, Bantay, and at Bio Tagudin; sand quarrying at Namruangan, Cabugao and at Libtong, Tagudin; and mountain quarrying at Nalvo, Sta. Maria. The quarry sites mentioned were described to be from excessive to highly excessive. In Ilocos Norte, the researchers noted three types of quarrying: clay extraction at Sta. Monica, San Nicolas; sand quarrying at Paoay; and gravel extractions at Bengcag, Barangays, Laoag City, as well as in Bacarra. A shift in the original course of the San Cristobal, Sarrat River has been confirmed by the residents. They attributed the rerouted course of the river to the continuous unplanned gravel extraction therein. They have further examined the physical changes or environmental effects of the quarrying operations for sand, gravel, earth and mountain quarrying separately and suggested the mitigation measures also.

A Series of Environmental Impact Assessment (EIA) studies undertaken in the recent years by various personnel have concentrated on EIA of quarrying. Singh (1993) has dealt mainly with migrational pattern, income and in particular structural changes of workers occupation. Nandini et al., (1995) has attempted to study the impact of stone quarrying on the worker’s health. Kumar (1987) has identified the effects of mining i.e. the ugly scars on the earth’s surface, destroyed vegetation,
reduced soil fertility, degraded human and animal habitat, vibrations caused due to blasting, noise pollution of water bodies and health hazards created. Ghosh and Saxena (1995) have studied the societal damage caused by mining. Singh et al., (1996) have mentioned about the effect of dust on human health. Semban and Chandrasekaran (2000) have made survey to study the impact of crusher pollution on workers in Trichy.

Andre de Siqueira Campos Boclin et al (2006) in their work presents a decision support method for environmental impact assessment, using a fuzzy logic computational approach. It aims at offering stakeholders a way to operate fuzzy and crisp variables and make inferences from resultant values of the systemic indicator as well as environmental, cultural, social and economic thematic indicators.

Lubos Matejicke et al (2006) attempted a GIS-based approach to spatio-temporal analysis of environmental pollution in urban areas using LIDAR data. The study includes the processing of a wide range of air, water and soil pollution data and noise assessment and waste management data. Other spatial inputs consist of data from remote sensing and GPS field measurements. Integration and spatial data management are carried out within the framework of a GIS. From a modeling point of view, they have used GIS mainly for the preprocessing and postprocessing of data to be displayed in digital map layers and visualized in 3D scenes. Moreover, for preprocessing and post-processing, deterministic and geostatistical methods (IDW, ordinary kriging) are used for spatial interpolation; geoprocessing and raster algebra are used in multi-criteria evaluation and risk assessment methods. GIS is also used as a platform for spatio-temporal analyses or for building relationships between the GIS database and stand-alone modeling tools.

Lansana Coulibaly et al (2004) developed a multimedia model using publicly available GIS data, chemical release information and local monitoring networks to assess the fate of trichloroethylene (TCE) within the Passaic River Watershed. Seven environmental media, air, water, sediment, surface soil, terrestrial vegetation, root zone soil and vadose zone soil, were modeled in this study along with their sub-compartments.

Monika Peterlin et al (2008) described a method for the assessment of changes in environmental perception during an EIA process. The method of
measurement addresses the statistical significance of the influence of the content, form, mode, providers of environmental information, institutional constraint and other factors. The difference formed the basis for an assessment of how environmental information provided during an EIA process contributes to environmental perception.

Geraldo Stachetti Rodrigues et al (2003) examined an environmental impact assessment system or agricultural research and development. A strategic planning process was implemented at the Brazilian Agricultural Research Agency (Embrapa) to introduce sustainable agriculture concepts in all steps of Research and Development (R&D). An essential part of the devised mission statement called for the impact assessment of all technology innovation resulting from research and development, under field conditions (ex-post). They have developed the environmental impact assessment (EIA) system (AMBITEC-AGRO) to attend the demand is composed by a set of weighing matrices constructed in an electronic spreadsheet. Impact indicators were evaluated in the field in an interview/survey, and weighed according to their spatial scale and importance toward effecting environmental impacts.

Jens Kvaerner et al (2006) examined the content and use of the vulnerability concept in the IVM approach, and discussed the concept in an EIA context. The vulnerability concept is best suited to overview analyses and large scale spatial considerations. The concept is particularly useful in the early stages of EIA when alternatives are designed and screened.

Jennifer Nash and John Ehrenfeld (1997) examined five codes of environmental management practice: Responsible Care, the International Chamber of Commerce’s Business Charter for Sustainable Development, ISO 14000, the CERES Principles, and The Natural Step. The first three codes have been drafted and promoted primarily by industry; the others have been developed by non-industry groups. These codes have spurred participating firms to introduce new practices, including the institution of environmental management systems, public environmental reporting, and community advisory panels. The extent to which codes are introducing a process of cultural change was considered in terms of four dimensions: new consciousness, norms, organization, and tools.
Hallie Eakin and Amy Lynd Luers (2006) highlighted the new insights into the conceptualization of the vulnerability of social-environmental systems and identify critical points of convergence of what otherwise might be characterized as disparate fields of research. They have argued that a diversity of approaches to studying vulnerability is necessary in order to address the full complexity of the concept and that the approaches are in large part complementary. An emerging consensus on the issues of critical importance to vulnerability reduction including concerns of equity and social justice and growing synergy among conceptual frameworks promise even greater relevancy and utility for decision makers in the near future. They have synthesized the current literature with an outline of core assessment components and key questions to guide the trajectory of future research.

David Lawrence (2003) explained the avoidable pitfalls in Environmental Impact Assessment Practice. They explained that EIA processes and documents are frequently lengthy, complex, controversial, and uncertain all of which is well and good. But such contextual factors are not always at the root of the difficulties encountered in EIA practice. Sometimes the problems that emerge are at least partially attributable to the failure of EIA project managers and study teams to avoid readily identifiable pitfalls. Experienced EIA practitioners should be aware both of the potential pitfalls and of the means of preventing them from occurring or, at least, of promptly ameliorating adverse consequences as they arise. Competence-related problems continue to occur in the EIA process, notwithstanding ample, readily available advice and guidance that should minimize such problems. Perhaps this gap between knowledge and execution can be partially explained by a failure to focus on recurrent, avoidable, competence-related pitfalls. Twenty examples of such problems are also described in their work.

Anastassios Perdicoulis and John Glasson (2006) examined the causal network in EIA. Their work reviews the causal typology of networks in EIA as well as in other academic and professional fields, verifies their contribution to EIA against the principles and requirements of the process, and discusses alternative scenarios for their future in EIA.

Frederik Pischke and Matthew Cashmore (2006) have conducted an empirical study of decision oriented environmental assessment its theory and
methods. The study involves critically analysing the decision-oriented Environmental Impact Assessment system of the German Development Cooperation (a bilateral development assistance agency) using a modified version of a recent conceptual and methodological development, Analytical Strategic Environmental Assessment. The results indicated that some aspects of decision-oriented theory offer considerable potential for environmental assessment process management, and should be employed routinely. Yet uncertainty remains about whether certain core concepts, notably the detailed priority description of decision processes, can be achieved in practice. The analysis also indicates that there is considerably more common ground in many contemporary debates about environmental assessment than the literature, which has tended towards polarisation suggests. The significance of their study is that it recognises and highlights the contribution of decision-oriented theory to refocusing attention on the substantive intent of this globally significant policy tool.

Ritu Paliwal (2006) examined the EIA practice in India and its evaluation using Strength, Weakness, Opportunity and Threat (SWOT) analysis. He has suggested that there are several issues that need to be readdressed. It highlights several constraints, ranging from improper screening and scoping guidelines to ineffective monitoring and post project evaluation. The opportunities are realised as increasing public awareness, initiatives of environmental groups and business community and forward thinking to integrate environmental consideration into plans and policies. He opined that poor governance, rapid economic reforms, and favours to small-scale units are some of the foreseen threats to the system.

Ciaran Faircheallaigh (2007) draws on the Canadian experience to consider the potential of negotiated agreements to address two issues widely recognised in academic and policy debates on EIA and environmental management. The first relates to the need to secure indigenous participation in environmental management of major projects that affect indigenous peoples. The second and broader issue involves the necessity for specific initiatives to ensure effective follow-up of EIA.

Michael Matthies et al (2007) evaluated the Environmental decision support systems, current issues, methods and tools. He opined that development of Environmental Decision Support Systems (EDSS) is rapidly progressing. The
sustainable management of natural resources has a growing research focus as the awareness of the complexity of interactions between socio-cultural, economical and biophysical system components is increasingly acknowledged. As better data and methods become available, the complexity of the system representation is augmented. At the same time realism and relevance are increasing and allowing direct support for management and policy development. His work gives the background of recent developments in EDSS.

Padmalal et al (2008) studied the environmental effects of river sand mining from the river catchments of Vembanad Lake, Southwest coast of India. They have explained that rivers in the southwest coast of India are under immense pressure due to various kinds of human activities among which indiscriminate extraction of construction grade sand is the most disastrous one. The situation is rather alarming in the rivers draining the Vembanad lake catchments as the area hosts one of the fastest developing urban-cum-industrial centre, the Kochi city. The Vembanad Lake catchments are drained by seven rivers whose length varies between 78 and 244 km and catchment area between 847 and 5,398 km². On an average, 11.73 million \(\text{ty}^{-1}\) of sand and gravel are being extracted from the active channels and 0.414 million \(\text{ty}^{-1}\) of sand from the river floodplains. The quantity of instream mining is about 40 times the higher than the sand input estimated in the gauging stations. As a result of indiscriminate sand mining, the riverbed in the storage zone is getting lowered at a rate of 7–15 cm \(\text{y}^{-1}\) over the past two decades. This, in turn, imposes severe damages to the physical and biological environments of these river systems.

Samom Muttamara (1996) in his work graphically presented the governmental EIA process and approval procedure for public and private sectors. He explained that the National Environment Board (NEB) has developed a national framework on EIA process, requires the proponents of projects which fall into certain categories and magnitudes to submit a report concerning the study, and measures for the prevention of and remedy for the adverse effects on environmental quality.

Heli Saarikoski (2000) has attempted a collaborative problem-solving approach to environmental impact assessment of regional waste management strategy in Pirkanmaa, Finland. He has suggested that collaborative EIA can serve as
a learning and civic discovery process where people can act together and find new solutions.

Sylvain Payraudeau et al (2005) provide an analysis of six main types of methods for environmental impact assessment for a farming region: environmental risk mapping, life cycle analysis, environmental impact assessment, multi-agent system, linear programming and agro-environmental indicators. They have carried out eleven case studies, in which one of the six methods was applied. All methods are based on a set of environmental objectives. Some methods also take account of economic and social objectives to produce a more wide-ranging assessment of the sustainability of the agricultural system studied. Each method relies on indicators serving as criteria to evaluate whether the objectives have been attained. These indicators take account of local impacts such as noise, regional impacts such as eutrophication, or global impacts like the greenhouse effect. The characteristics required to develop a method for the environmental impact assessment of a farming region are discussed. The analysis of the interactions between farms is indispensable at this scale of analysis.

Steven A. Kennett (1995) examines significant process-design issues raised by both research and development contexts regarding EIA. The research context presents a choice between stand-alone EIA and its integration into general project evaluation. An adaptive approach to EIA is also discussed, particularly regarding the scoping issue of whether EIA should extend beyond research activities to the application of research outcomes. EIA could also be applied to the research funding policies of donor agencies. The development context requires that differing values be incorporated, since EIA methods are not value-neutral. The use of indigenous knowledge and the capacity-building potential of EIA were also discussed. His work concludes that well-designed EIA could enhance the environmental quality of development-oriented research and its outcomes, and contribute to environmental capacity building.

Ying-Ming Wang et al (2006) in their study applied evidential reasoning approach to conduct EIA analysis. The environmental impact consequences are characterized by a set of assessment grades that are assumed to be collectively exhaustive and mutually exclusive. All assessment information, quantitative or
qualitative, complete or incomplete, and precise or imprecise, is modelled using a unified framework of a belief structure. A numerical example and its modified version were also studied to illustrate the detailed implementation process of the ER approach and demonstrated its potential applications in EIA.

Sara Bruhn-Tysk and Mats Eklund (2002) explained that properly performed, EIA is a useful tool for promoting sustainable development because it includes many components that can help facilitate intragenerational and intergenerational equity. In a case study they have analysed the EISs for Swedish biofuelled energy plants to see whether they include components vital to meet intra- and intergenerational equity, such as assessing local and global impacts, use of resources, public influence on project development, and alternative project design. The analysis shows that the environmental aspects of sustainable development on a local level are only partly met by EIA. However, global effects and effects on the management of natural resources are not assessed, excluding aspects that may affect future generations. Based on this, and since no concerns for sustainable development on a societal level were found, it is concluded that EIA practice in Sweden may not, to a full extent, serve as a tool to promote sustainable development.

Lars Erikstad et al (2008) examined the environmental value assessment in a multidisciplinary EIA setting. They explained that value assessment is a central element in an EIA for the understanding of the impacts of specified projects. The value assessment contains subjective elements and this may cause errors and difficulties in numeric value assessment methods. They have opined that there is a need for transparent common criteria to promote discussion and understanding. A common criteria base already exists, but lack of communication between different management systems and different disciplines, all with different traditions in value assessment, makes the situation complex. In their article they have looked into the basic understanding of value linked to the investigation themes of natural environment, cultural heritage and society. The investigation themes linked to social science is difficult to incorporate into a common system, basically because they have less focus on land use and contain different value types. Much of the relevant literature about value assessment is linked to the assessment of sites of special interest as candidates for legal protection or conservation. In an EIA a much broader
range of areas is introduced, including the “every day landscape” with a lower and more general level of value. Together with a focus on mitigation and adjustments of plans, this results in a need for a more detailed value assessment scale than is normally in use today. They have suggested a new scale to ease communication between different disciplines and management systems. The need for a dynamic value assessment system increases with the increasing use of database modelling, digital analysis of map data (GIS) etc. Lack of ongoing value debate will rapidly lead to misleading and biased results.

Richard Ellis and Peter Scott (2004) evaluated the hyperspectral remote sensing as a means of environmental monitoring in the St. Austell China clay (kaolin) region, Cornwall, UK. They have processed the HyMapR hyperspectral data to correct for atmospheric and illumination effects by calibration from radiance to reflectance data, so that mineral abundance maps could be produced. Minerals associated with the primary granite and its subsequent kaolinisation were identified by image processing and used as mapping end members. These minerals include kaolinite, kaolinite with smectite, montmorillonite, muscovite, lepidolite (lithium mica) and topaz. Hyperspectral data analysis allowed for the identification of the different primary granite units.

Jerry S. Kuma et al (2002) examined the expanding hydrogeological base in mining EIA studies with a special reference on Ghana mining sector. They argues that apart from improving mining EIA practices, the proposed approach can also yield dividends for the mine operator, in terms of helping to find water for mine needs, and minimising water ingress to workings and associated pollutant release.

Maria Dubikova et al (2002) designed a laboratory experiment to investigate the interaction of Acid Mine Drainage (AMD) with soils. The study used three undisturbed cambisol columns from the mining region of Slovakia. Their study shows that different formations and transformations of minerals in acidified columns: amorphous Fe-oxyhydroxides were formed in both AMD and H2SO4 leached soils in the form of a characteristic “mohair” structure rich in Al and Si when AMD was applied.
Clemens and Robert (2005) in their study the definitions and use of the term geochemical “background” in exploration and environmental geochemistry are reviewed. Based on data from two sub-continental scale geochemical mapping projects, it was shown that trying to define “background” for a large area is fraught with problems. It was demonstrated that background may change from area to area within a region and between regions. Although global averages are of general use, no specific global background levels of elements, for example in soils, can be defined, at best regional or local operational estimates can be made, though with caveats.

Harald Sverdrup (1996) examined the importance of geochemistry in understanding the environment chemistry. He has carried a modeling of weathering rates in the field from geochemical and geophysical properties. The weathering model in PROFILE is a reductionistic type of model, where the main mechanism is based on a set of parallel molecular mechanisms at the mineral surface. Rate coefficients in the models have been taken from laboratory studies. Geochemistry is of overriding importance in analysing and understanding a large number of important environmental issues. Acidification of soils and waters are connected closely to the geochemistry of weathering. Weathering of soils and rocks represents the only self-repairing mechanism for acidified ecosystems. Recent research in Scandinavia has provided new concepts and new modelling tools for calculating rates of field weathering and assessing its interactions with other soil processes.

Wardi et al (2000) explained that the Geographic Information Systems (GIS) are useful tools for identifying populations with potential exposure to environmental contaminants. Using a GIS, features of the local environment around an individual’s home, work, or school can be described. They have presented two examples illustrating methods and issues in identifying populations potentially exposed to agricultural pesticides and to toxic releases from the Toxic Release Inventory (TRI).

Peter Zeilhofer (2008) evaluated the environmental impacts caused by informal occupation in the city of Cuiaba, Mato Grosso, Brazil. In 10 selected districts, an assessment of 35 environmental indicators was conducted, evaluating secondary data as well as old survey results, air photo interpretation and Geographical Information System (GIS) analysis. He has applied matrix approach to
quantify the magnitude and relevance of surface water, soil, flora/fauna, air and land use and life quality. Impacts were analyzed in the spatial context of four main classes of municipal zoning. Redundancy Analysis (RDA), a multivariate ordination method, was applied to evaluate the dependency of impacts from environmental and socio-economical factors.

Ines Sante Riveira et al (2008) describes a planning support system for rural land-use allocation. The system is called RULES (Rural Land-use Exploration System) and is based on a Geographic Information System (GIS). Other software components have been incorporated into the GIS to link external analytical models to the system. These analytical techniques support three basic stages in a rural land-use planning model: land suitability evaluation, land-use area optimization, and spatial allocation of land uses. They have carried out land evaluation using multi-criteria evaluation methods and the FAO framework and used a multi-objective linear programming model designed for the optimization of land-use areas, where the objectives include economic, social, and environmental aspects.

Elsa Joao (2002) evaluated the influence of geographical scale on the outcomes of Environmental Impact Assessments (EIAs). His work presents results obtained by using spatial data with different scales for an EIA for a proposed road bypass in Southeast England (the Hastings Bypass). Scale effects were measured separately for spatial extent and spatial detail, and were measured both quantitatively using a Geographical Information System (GIS) and qualitatively using the judgment of EIA experts. The study found that changes in scale could affect the results of EIAs.

Final report on initial environmental examination Section D – Thrissur (2007) addresses the potential environmental impacts of the infrastructure components proposed for implementation in the Thrissur Corporation area. The infrastructure components are drawn from the sectors such as water Supply Rehabilitation; Sanitation Infrastructure Upgrade; City Drainage Refurbishment; Solid Waste Management and Disposal; and Road Upgrades.

Tang Tao (2007) attempted integrating the environment into land-use planning through strategic environmental assessment in China. His work aims to
investigate why and how Strategic Environmental Assessment (SEA) is enacted as an effective tool to integrate the environment into land-use planning during the construction process of an environmentally friendly society in China, and identify factors that influence the integration. It presents characteristics of the land-use planning system, and reviews the progress and current state of SEA in China. Results show that SEA provides many benefits in promoting environmental considerations into the land-use planning process. The legal frameworks and operational procedures, in the context of land-use master planning SEA, are summarized and an assessment made of their effectiveness. Some barriers are highlighted through examination of the latest case studies, and several recommendations are presented to overcome these obstacles.

Jan Frouz et al (2008) studied the Interactions between soil development, vegetation and soil fauna during spontaneous succession in post mining sites. They have investigated more than 50 parameters of vegetation, soil and soil fauna in 27 non-reclaimed post mining sites of various age (1–41 years old) located near the town of Sokolov (Czech Republic).

Land is used for many purposes. It is also the focus of conflict between a wide range of land uses including agriculture, mining, forestry and nature protection, leisure, and urban and industrial development. Competition between users grows more under increasing population pressure and in countries with a mixed economy. Decision making on land use options is therefore a current problem of modern societies. Adequate planning and decision making about land use is facilitated by a national soils policy framework. This is a set of guidelines, aimed at ensuring a sustainable utilization of the land either for agricultural or non-agricultural uses and limiting direct or indirect damage to the environment. The policy is integrated into a national development plan, and addresses the natural diversity and specific physical and socio-economic problems of the region concerned. National soils policies are therefore very country specific; they rely on clearly defined long-term objectives and involve strategies and tools for implementation. A number of examples are given to illustrate the most relevant issues in national soils policies. Willy H. Verhey (1997) examined the landuse planning and national soils policy.
Paul Younger and Christian Wolkersdorfer (2004) edited the EEMITE Consortium document on Mining Impacts on the Fresh Water Environment: Technical and Managerial Guidelines for Catchment Scale Management. The document provides guidance on approaches to catchment scale water management which are appropriate to mined environments. They have presented results from a site-specific conceptual cost-minimization model applied to the determination of cost-effective allocation of mine waste remediation and/or mine water pollution abatement measures within the Dal River catchment, in order to achieve targeted Zn, Cu and Cd load reductions to the Dal River and to selected local mine water recipients. They have considered various, practically feasible remediation measures and designs, including soil and water covering of the mine waste deposits, and downstream wetland construction close to the compliance boundaries (CBs) associated with the different investigated mine water recipients. They have also calculated the cost-efficient measure allocation, and associated total and marginal costs for compliance to different environmental targets.

Samouëlian and Cornu (2008) present a literature review of the different approaches in deterministic modelling of pedogenesis, as well as of models developed in other scientific fields that might be adapted to pedogenetic problems. They distinguish two types of modelling, deriving from a so-called classic soil science approach based exclusively on the analysis of the soil solid phase, and deriving from other scientific fields in particular environmental and mining that also integrate circulating water. The advantages and limitations of each approach are discussed.

John Thomas et al (2003) in their report on Muriyad wetlands: ecological changes and human consequences discusses in detail about the various threats faced by the Muriyad wetland system, which forms part of Vembanad-Kol, a Ramsar site.

Pierre Senecal et al (1999) describe the purposes, aims, and approach used to develop the Principles; and presents the definition of EIA, its objectives, and the Principles of EIA Best Practice. The Principles of EIA Best Practice are designed primarily for reference and use by those professionally involved in environmental impact assessment. The aim is to promote the effective practice of environmental impact assessment consistent with the institutional and process arrangements that are
in force in different countries. Accordingly, the Principles are broad, generic, and non-prescriptive, emphasize EIA as a process, and are intended to be applicable to all levels and types of proposals, having regard to the limits of available time, information and resources.

El-Shall and Patrick Zhang (2004) initiated a research to investigate the effect of fibrous material on the flocculation and dewatering of mine wastes from several mining industries including phosphates, kaolin, and bauxite. Several dewatering techniques were investigated, including sedimentation thickening; filtration; centrifugation; dewatering on screens; and seepage-induced dewatering and consolidation. This paper discusses the results obtained in various stages of development of this patented process.

Nicola Hartley and Christopher Wood (2005) explore the nature of public participation in the Environmental Impact Assessment (EIA) process in the context of the potential integration of the Aarhus Convention principles into the UK EIA system. Ten practice evaluation criteria derived from the Aarhus Convention are used to analyse the public participation procedures used in four UK waste disposal EIA case studies. The paper reports the extent to which the practice evaluation criteria were fulfilled, explores the types and effectiveness of the participation methods used in the EIAs, and highlights some of the key barriers that appear to impede the execution of dearly and defective participation programmes.

In Theory & Practice of Strategic Environmental Assessment: Towards a More Systematic Approach, Thomas Fischer (2007) argues that the diverse applications of SEA around the world would benefit from following ‘certain core principles’ that should ‘underlie any SEA’. Building on this assumption Fischer sets out to develop and promote a more systematic approach to SEA, and outlines four objectives for the book: to portray current conceptual ideas and further develop these, to provide an overview of fundamental principles and rules of SEA, to report on SEA practice according to a systematic framework, and to advance SEA theory.

Scenarios and scenario analysis have become popular approaches in organizational planning and participatory exercises in pursuit of sustainable development. However, they are little used, at least in any formal way, in EIA. This
is puzzling because EIA is a process specifically dedicated to exploring options for more-sustainable (i.e., less environmentally damaging) futures. Peter N Duinker and Lorne A. Greig (2007) review the state of the art associated with scenarios and scenario analysis, and describe two areas where scenario analysis could be particularly helpful in EIA: (a) in defining future developments for cumulative effects assessment; and (b) in considering the influence of contextual change – e.g. climate change on impact forecasts for specific projects. They concluded by encouraging EIA practitioners to learn about the promise of scenario-based analysis and implement scenario-based methods so that EIA can become more effective in fostering sustainable development.

Tim Snell and Richard Cowell (2006) argue that implementation deficits reflect dilemmas between two key rationales for scoping environmental precaution and decision-making efficiency and between technical and participatory conceptions of the decision-making process. They have used qualitative research to understand how scoping practice in the UK reconciles competing imperatives. Their findings suggest that practitioners mainly rationalise their approach in terms of decision-making efficiency, while justifying excluding the public from scoping on grounds of prematurity, delay and risks of causing confusion. The tendency to scope issues in rather than exclude them reflects a pervasive concern for legal challenge, rather than environmental precaution, but this reinforces standard lists of environmental considerations rather than the investigation of novel, cumulative or indirect risks.

Dong Qing-hong et al (2007) simulated fissure development in clay layers at the bottom of Quaternary strata and above bedrock, sand and water inrush during mining by model experiments. The results show that V-shaped fissures usually occur in the bottom clay layer at the front top of the active face and that the position of these fissures changes periodically with ground pressure intervals. These fissures occur exactly in the area where the horizontal strain is concentrated. The results also demonstrate that the permeability coefficient of the cracked clay decreases while fissures tend to close.

Marafa (2002) discusses the increasing importance of the environment to social scientists. A multi-disciplinary approach is highlighted and it is argued that the social sciences have a more significant role to play in understanding and
responding to environmental deterioration than has hitherto been the case. The need for harmonizing multi-disciplinarily in appreciating impact assessments is emphasized. A framework for analyzing and containing environmental impacts in Hong Kong is also proposed.

Abrahams (2002) reviews how the health of humans is affected by the world’s soils, an association that to date has been under appreciated and under reported. Soils significantly influence a variety of functions (e.g. as a plant growth medium; its importance on the cycling of water; as a foundation for buildings) that sustains the human population. Through ingestion (either deliberate or involuntary), inhalation and dermal absorption, the mineral, chemical and biological components of soils can either be directly beneficial or detrimental to human health.

Davide Geneletti et al (2007) present and discuss the construction of a spatial decision-support tool for the Strategic Environmental Assessment (SEA) of a land use plan: the spatial coordination plan of the Province of Naples, in southern Italy. The decision-support tool organises the relevant information, spatially resolves the actions of the plan, predicts their environmental impacts, and generates overall performance maps. Its final goal is to provide a suitable technical support to a formal SEA procedure. The expected implications of the plan, such as changes in land use and traffic flows and urban expansion, were modelled and assessed against a set of environmental criteria using SWOT analysis and mapping.

Da Zhu and Jiang Ru (2007) examined how strategic environmental assessment has been practiced at the national level in China through 2005 and why it has been practiced in the manner observed. Based on literature reviews and interviews carried out in 2005 and 2006, they have found that bureaucratic politics between environmental and non-environmental ministries has limited the legislation and implementation of strategic environmental assessment to environmental assessment (EA) for a set of government plans depend in the 2003 Environmental Impact Assessment Law. Interviewees from environmental and non-environmental ministries and key research institutes have reported that few planning EAs have been performed at the sectoral level.
Paula Antunes et al (2001) presents a new methodology for impact assessment SIAM (Spatial Impact Assessment Methodology) which is based on the assumption that the importance of environmental impacts is dependent, among other things, on the spatial distribution of the effects and of the affected environment. The information generated by the use of GIS in impact identification and prediction stages of EIA is used in the assessment of impact significance by the computation of a set of impact indices. For each environmental component (e.g., air pollution, water resources, and biological resources), impact indices were calculated based on the spatial distribution of impacts.

Jan Frouz et al (2007) evaluated the effect of litter quality and soil faunal composition on organic matter dynamics in post-mining soil. They have carried out a laboratory study by constructing laboratory microcosms consisting of mineral soil (alkaline clay spoil substrate from brown-coalmine tailings) and two types of litter: (1) taken from a non-reclaimed site with naturally developed vegetation (mostly Salix caprea) or (2) collected from an alder plantation (a mixture of Alnus glutinosa and A. incana).

Einar Leknes (2001) clarifies the roles that EIA can have in decision making in different conditions that the project is required to meet. Three common decision-theoretical perspectives are used to illustrate the decision making process. He has studied EIAs of 45 petroleum field development projects. This empirical research shows that the framework- based on the three types of decision process and a classification of issues according to the type of content and form of governance- provides a useful tool for understanding the role EIAs can have in decision making process.

Hsing-Chung Chang et al (2004) demonstrated a cost-effective space technology, Differential Interferometric Synthetic Aperture Radar (DInSAR), which is complementary to the conventional field surveying techniques for monitoring land subsidence due to underground mining. Three underground coal mines located in eastern New South Wales, Australia, have been studied using DInSAR. Spaceborne SAR images acquired by ERS-1/2 and JERS-1 satellites were carefully selected to form interferometric pairs. DInSAR measures ground surface deformation by eliminating the topography from its interferogram. This can be done by introducing
an external Digital Elevation Model (DEM). The vertical accuracy of the DEM used reflects the minimum detectable phase signal of DInSAR. They have assessed three DEMs derived from a range of remote sensing techniques for use in DInSAR processing.

Raphael Mwalyosi (2004) discussed EIA and the mining industry in Tanzania. He explained that in the past, environmental management in mining has been hindered by lack of coordination, insufficient funding and expertise. As a result there has been uncontrolled extraction of minerals and the use of unsafe mining methods and severe environmental damage and appalling living conditions in the mining communities. The challenge associated with the mining sector today in Tanzania is ensuring sustainability and integrating environmental and social concerns into mineral development programmes. Sustainable mining development requires balancing the protection of the flora and fauna and the natural environment with the need for social and economic development. In view of these challenges, the Government’s policy for the development of the mining sector aims at attracting and enabling the private sector to take the lead in exploration, mining development, mineral beneficiation and marketing. The role of the public sector will be to stimulate and guide private mining investment by administering, regulating and promoting the growth of the sector. To address the problems associated with mining, the Government’s policy is to reduce or eliminate the adverse environmental effects of mining, improve health and safety conditions in mining areas, and address social issues affecting local communities. EIA is recommended as one of the major tools for achieving these solutions. Although EIA will soon be a legal requirement in all development activities including mining, it may take many years to achieve the set objectives since the necessary EIA culture and relevant institutions to coordinate and manage the mining environment have to be built.

EIA notification published by Ministry of Environment and Forest, Government of India (2006) provides guidelines for EIA study for Industrial project including mining industries. It has mentioned in the notification that EIA study is required to mining projects covering an area greater that 5 ha.

A project funded by the Europian Community under the “Information Society Technology” (2002) provides general guidelines for modelling mining-
related pollution dissemination from Earth Observation (EO) and GIS data. General guidelines for rehabilitation and remediation. The report says that the state of the art in processing hyperspectral remote sensing data represents a real paradigm shift compared to standard image processing. It's no longer necessary to rely on pure mathematical classification algorithms producing ambiguous results because of the lack of spectral information, but to actually identify the composition of the ground material by its characteristic spectral signature. This significantly increases the number of materials that can be differentiated and improves the precision of the chemical or mineralogical differentiation/identification in the imaged target. This report intends to present general guidelines for the assessment and monitoring of the environmental impact of mining activities using EO data together with other relevant data. EO data, when integrated into GIS and combined with other data relevant to environmental concerns, have been proven valuable in the EIA of mining, both at local and regional scales. In particular, they can be used in the production of pollution-risk maps around mining areas and to develop models for understanding pollution dissemination. Indeed, decision-aiding documents take advantage of cartographic representation. GIS and Data Base Management Systems (DBMS) allow three-dimensional (3D) processing of data into a single cartographic projection, whatever their origin. They enable the analyst to take many parameters into account simultaneously, thus improving the quality of the result, and process data on a standard form based on homogeneous criteria over the whole of the study area, leading to a homogeneous result.

Mehrotra and Suri (1994) edited and compiled a book on *Remote Sensing for Environment and Forest Management*. In the book Baldev Sahai reviews various studies, which have bearing on environment, carried out in India during last few years. Njoku in chapter 2 focusses on importance of space borne microwave radiometry and its application to land resources. Gopal Rao in Chapter 3 discusses both aerial photography and the use of satellite imagery and makes a useful comparison between them. These techniques are particularly useful for recording assessment and monitoring of urbanization. He reviewed few case studies which have been carried out in India. Section two dealing with various articles on forests and wildlife commences with Hoekman and Van der Sandens' dealing with assessment and monitoring of conditions in the forest environment Jadhav in
Chapter 5 discusses the informations required for forest classification and inventory system. He and his associates have carried out various studies on such aspects, and are discussed in detail. A chapter dealing with forest management follows. Madhavan Unni reviewed applications of remote sensing for forestry management. He indicates that the information gained can be used to develop Forest Resources Information System (FRIS) and Forest Protection Information System (FPIS) encompassing all aspects of forest management with a holistic approach. Inamdar in Chapter 8 assesses geological features of vegetated areas with a specific case study. Assessment of wildlife habitats is another important application of remote sensing. Parihar and Panigrahy in Chapter 9 candidly explain their approach of habitat studies. The last section dealing with Geographical Information Systems commences with Prof. Burrough's dealing with principles of GIS in Chapter 10. Young's Chapter 11 discusses with vivid use of GIS in support of remote sensing in detail. Mehrotra and Suri in the last chapter overview the historical and recent perspectives of man's role in management. They emphasize that economic, scientific and technological transitions with human perspective are imperative for better management of global environment. Madhavan Unni and Parihar and Panigrahy's articles are reproduced with their consent.

John Merefield et al (1994) examined the fugitive dust characterization in opencast mining areas. They chart the setting up of low-cost dust collecting technology and sophisticated analysis for the mineralogical characterisation of airborne dust. A complex situation has been unraveled showing a composite of ambient and continental dust mixing with dust from mining activity and with particulates from quarrying operations, roads and industry. This new dust data technology has proven particularly effective and will be of considerable use in the implementation of future environmental protection legislation in Europe and worldwide.

Sastry et al (1994) studied the respirable dust concentration at various sources at different mines and crushing plants belonging to a large steel plant. Spanning over three months several measurements were made for dust using gravimetric dust samplers. Silica analysis was done for the deposited dust samples from X-ray diffractograms. The instruments used as well as the measurement
technique were in conformity with DGMS guidelines. Typical operations studied in different mines produced dust levels both below and above TLV (Threshold Limit Value). It is concluded that drilling operations in mines and many operations in ore treatment and handling plants produce dust levels above the TLV of 3 mg/m³. Operations including shoveling and hauling, and haul roads as such are noticed to have concentrations within acceptable limits. They found that except for a quartzite mine, the free silica content in the respirable dust in all locations was found below 5%.

Moitra and Ramaswamy (1994) examined the haul road dust consolidation in open cast mines with a new approach. He explains that the mechanisation of mining has invited a few environmental problems which defy solution. Road dust problem in open cast mine is one such. Haul road dust is formed of a spectrum of sizes, from submicronic particles to larger pieces of a few centimeter diameter. Loaded dumpers moving at high speeds crush the larger pieces. Spillage from these vehicles adds to the dust load of the haul roads. Added to this is the accumulated neglect of these roads over periods. Haul roads often show 4 - 6" or more (even upto 18") of accumulated dust on the surface) the dust is a potential source of pollution. The road dust may contain 3 - 4% or more (up to 12%) of particles which could easily get air borne during adverse conditions - so much so, that dumper could disappear from sight while in motion. It is not an uncommon experience that the dumper comes to stand still due to poor visibility on account of air borne dust. The dust is injurious to men, machinery, buildings, vegetation and water resources besides its other known adverse effect on productivity. Agarwal et al (1994) tried with the help of case studies to discuss the various effective means in detail such as roadheader cutter head design parameters, to control generation and the water based dust control measures.

Tripathy and Patnaik (1994) discussed the results of noise studies in an opencast mine and analyses the SPL (dBA) produced by different machinery in this mine. Further, it focuses on the adverse effects of noise and lists the instruments available for noise monitoring. It also presents the noise standards recommended in India and abroad and suggests the noise abatement strategies to be adopted for protecting the workers against NIHL.
Edworthy (1994) examined the various effects of mining on groundwater quality and resources. He explains that Mining excavations intercept groundwater flow, often down to considerable depth. Indeed groundwater frequently causes serious difficulties during the development and operation of mines, particularly where the style of the permeability is such that sudden high rates of inflow occur in an apparently random fashion. While the effects are quite evident on the mining environment, the effects of the large distortions on the natural pattern of groundwater flow orientation and chemical quality, on the environment at large, are often longer term and more suitable. Measurable effects, and sometimes contamination, may take some time to appear. While deep-mining of most types usually has the most noticeable involvement with groundwater. Quarrying and open cast mining can also cause conspicuous effects on groundwater level and quality as observed in the Tobago mineral sand mining area of New South Wales Australia (Viswanathan 1990). In Germany, opencast mining of lignite causes extreme drawdown of surrounding groundwater levels, one effect of which is to make the abstraction of public groundwater supplies significantly more expensive (Orlovski et ai, 1986). More exotic developments such as solution mining have a serve effects on both groundwater and aquifer, but luckily such operations are few at the moment. The most serious and widespread environmental effects of mining however emanate from the disposal or storage of spoil and groundwater tends to be especially badly affected. Geotechnical problems such subsidence may be further effects of groundwater abstraction for mine dewatering, and there is much evidence that the lesser degrees of deformation due to mining on the surrounding rocks can enhance permeability (Boot1986).

Muthreja (1994) discussed heavy metal contamination in groundwater and surface water. The observations are based on the studies carried out the authors in the areas of old mine sites of South-West England and some of the Manganese Mines of India.

Badrinath et al (1994) highlighted a few case studies carried out to understand the biological environmental impact assessment due mining activity and also discuss the management plan for restoration of the mined areas and degraded lands.
Singh (1994) examined the impacts on Land uses and on habitats. It assesses Socio-economic impacts and furnishes financial implications of rehabilitation. Some suggestions have also been given to neutralize the stresses developed due to Coal Projects.

Ramachandra Rao et al (1994) describe the impact of mining projects on socio-economics. He explained mining of mineral deposits, if exploited economically, would generate prospects of significant employment of non-inflationary nature, in developing countries. Exploitation of remotely located mineral deposits contributes in developing inaccessible regions thereby improving socio-economics of the region benefiting the local inhabitants and supplementing the efforts towards national integration. However, an indifferent attitude of the project management towards environment and welfare of local population will result in clash of interests and perpetual litigations which not only impede progress of the project but also lead to law and order problems. A precondition for successful implementation of any project is to understand the possible impact it has, on the socio-economics of the region and educate the local inhabitants to derive optimum advantage from the project.

Pal (1994) opined that advanced technology in the mining activities are polluting the natural environment, interfering the normal life of the miners-residents. He examined health hazards due to underground workings and effect of environmental condition on men. Composite System inter-relationship of the mining Industries with the Government, Society and Environmental Sectors is established. Allowing certain level of pollution, a System Dynamics Model is developed considering the parameters like more revenues from the mining industries, degradation of quality of life index - environmental -index on long-term and short-term basis, new diseases due to pollution, social awareness, health care facilities, tax exemption etc.

Phalguni Sen (1994) opined that surface Coal mines being the largest contributor to the national coal production, the study of environmental impacts due to this becomes mandatory as it will help in proper planning and safe operations of the mine in an environmentally compatible manner. Within the scope of his work, a model for preparation of comprehensive EPA by utilising a new evaluation
methodology leading to determination of Environmental Quality Designation (EQD), an index has been developed and validated the model.

Atkinson and Mitchell (1994) studied the causes of environmental impact from mineral extraction. The problems associated with contaminated land and some of the previous reclamation techniques are reviewed. Novel approaches to reclamation, Developed at Camborne School of Mines (CSM), are described. The theoretical properties of various industrial minerals their ability as in situ additions or amendments on contaminated land was presented. Mechanisms were described to explain the beneficial effects of such materials as Fuller’s earth, and certain zeolites, in treating contaminated land. Field trials of these and other materials are outlined. The relationship of these field trials to detailed laboratory tests was also discussed.

Saiz de Omenaca et al (1994) discussed the major aspects of Spanish Laws concerning the environment both positive and negative making reference to specific cases, especially to the opencast mine of Montehano from which dolomite was extracted.

Badrinath and Raman (1994) examined the sustainable development in Indian mines through Environmental Audit (EA). They have discussed that mining in India has been diversifying into progressively more capital intensive and energy intensive areas which are degrading the quality of environment. Considering the future Environmental and Energy scenarios, the impact, the mining has on environmental quality and occupational health safety of mine workers, EA deserves to be adopted as a pre-requisite for sustainable development and Environmental Management of Indian Mines. EA is a structured and comprehensive mechanism for ensuring that the mining activities do not adversely affect the Environmental Quality and the economy of mining sector improves as a consequence of improved process and energy effectively as also the occupational health and safety. They have emphasized that the successful EA program investigates all possibilities of energy saving, material saving and water budgeting through conservation of resources to protection of environment. They have presented the various options for environmental management in mining industry including reactive control measures on one hand and anticipative/preventive strategies on the other. Their work also
reviews the EA skills and audit protocols along with a discussion of key audit
techniques.

Bose (1994) discussed the environmental legislation for sustainable
development of Indian mines. He explained that the environmental legislation has
been developed in India during the last two decades or so. Specific legislation for
protection of environment in mines has been enacted between 1986 and 1988.
Mining plans introduced under the amended Act and Rules incorporate
Environmental Management Plans (EMP) as internal parts are approved by the
Indian Bureau of Mines (IBM), a national organisation under the Ministry of Mines
of the Government of India and their implementation is also monitored by the
Bureau. With subsequent enactments and amendments, an effective legislation
framework is now available for ensuring conservation of environment in Indian
mines.

Jayant Bhattacharya et al (1994) discussed about the pricing a means to
rectifying the environmental damage in mineral industry. They have explained that
the environmental protection and controls now a global concern. While time and
again many authors categorically stressed the restoration of environment, very little
effort has been made to develop economy of environmental control, mainly in the
field of mineral industry. They have further discussed in details the several
abatement options and their relative merits and demerits, where authors opine that
pricing be favoured.

Arlei Benedito Macedo (1994) explained that the protection of the
environment is guaranteed by the Brazilian Constitution of 1988 and is implemented
through numerous laws and regulations. Organised mines, run by companies,
generally observe the legal requirements but the unorganized 'garimpos' not only
exploit their workers but also cause serious environmental damage. In his work the
reclamation of mine sites and exploration scars, environmental protection during
extraction, contouring, new land use, re-vegetation, monitoring, water reclamation
and the aftercare of abandoned mines were evaluated, and the reclamation of some
areas affected by agriculture and industry in Brazil were also examined.
Heath et al (1994) investigated environmental impact of opencast copper and manganese mining in a region of tropical forest in central India. A wide range of impacts were studied including air quality, surface and groundwater contamination, soil contamination, noise and vibration, physical encroachment onto forest areas, effects on protected areas, and the rehabilitation and after-care of old mine sites. Central to the study was recognition of the economic importance of mining in terms of local, regional and national development, and the need to understand the socioeconomic impact of mineral development.


Kerala State Council for Science, Technology and Environment (2005) examined the river sand mining and management in Thrissur District, Kerala. They described that mining of river sand and gravel for various purposes has created conflicts in the environmental and socioeconomic scenarios of Kerala State. There have been numerous complaints from public as well as various NGOs against the indiscriminate river sand mining. As directed by the Hon’ble High Court and the Government of Kerala, CESS has conducted many studies on sand mining and related environmental issues of various river basins of the State for laying down strategies for future mining. The reviewed report is a district-wise update of the various sand mining studies carried out over the years in the Thrissur district. As per CESS records, a total of 19 local bodies located on either side of the Periyar (2), Chalakudy (7), Karuvannur (5) and Bharathapuzha (5) rivers are engaged in sand mining. They together mine about 1084 truck loads per day (tlpd) of sand through 97 kadavus. The quantity of sand mining is several folds higher than the natural replenishments and hence imposes severe environmental problems in the river basin environment. On the other side, sand mining provides employment opportunities to a considerable section of the labour force in the Thrissur district and supports the construction sector. Further, there are no viable alternatives available to this crucial construction material for immediate use. Taking all these into consideration, a resource allocation strategy that can balance the current demand and the emerging
environmental issues related to sand mining was worked out on a river basin mode and recommended for consideration of the concerned authorities for further action. A few additional suggestions were also made for improving the overall environmental quality of the area.

Department of Economics & Statistics, Government of Kerala (2006), prepared statistical information for decentralized planning. The report provides the demographic particulars, agriculture, animal husbandry, industries, power and water supply, transport and communication, public distribution system, health, education, rural development and other information such as rural sanitation, social and cultural institution, integrated habitant development programmes etc. of Thrissur district. Bruce Velde Alain Meunier (2008) stressed the role of plants at the bio-interface and the importance of microsystems at the water/rock interface. Their study shows that the system of clay formation and reaction is highly dynamic, especially at the surface. Clay alteration profiles are slow to form, thousands to hundreds of thousands of years, but they react quickly at the surface to chemical change, essentially engendered by plants. This is the message. Clays can react in short periods, years to tens of years, and hence should be considered as part of the active surface environment. They opined that a clear understanding of plant and soil interactions and the fundamental alteration processes is vital to stewardship of one of the most precious parts of nature, the soil zone. Surface clay minerals appear to react very rapidly to changes in environments, specifically changes in plant regime in soils. The high reactivity of this kind makes clay minerals potential indicators of changes in the Earth’s surface paleo-conditions and those engendered by the action of agricultural man.

Kumar (2005) examined the change in landuse in Kerala. He described that the agricultural land-use changes in Kerala during the past half-century were marked by an initial increase in total cropped area (26% between 1960 and 1969), followed by dramatic shifts in the coverage of individual crops. For example, rice area dropped by 60% between 1975 and 2003, while the cultivation of coconut, rubber, arecanut and banana with plantains increased spectacularly. Agricultural expansion coupled with over-exploitation of forests has affected the state’s forest ecosystems, however. Primary forests dropped substantially between 1940 and 1970 average loss
of publicly managed forests being 5000 ha per year. Satellite imageries show a further drop thereafter, with a concomitant loss of biodiversity. As monospecific cultivation methods became extensive and the live fences/scattered trees on farmlands were decimated, the capacity within the agricultural sector to meet its own demands also reduced, which in turn, increased the dependence on forest lands. In the light of environmental degradation and the need for climate change mitigation, a paradigm shift in the state’s land management is imperative. Agro-forestry, which aims at optimizing productivity and above all, sustainability, has the potential to provide many resources for which the people have traditionally depended on forests. Yet, as a modern land management strategy, agro-forestry has not received adequate attention in Kerala. Agro-forests if established on degraded lands will not only reduce the anthropogenic pressure on existing forest resources but also will enhance the sink potential of CO₂.

Jeena Srinivasan (2010) has attempted to understand the ecological and economic importance as well as the associated property rights issues of wetlands in general and the Kole wetlands in Thrissur, Kerala in particular. She also seeks to analyse the wetland agriculture interactions in Kole lands and identify the various livelihood and other activities undertaken with a purpose to identify the various interlinkages and feedbacks between various uses and the pressures facing the ecosystem. She has used the Driver Pressure State Impact Response (DPSIR) framework to understand wetland-agriculture interactions and the various pressures facing the ecosystem. It is seen that Kole lands support various types of onsite and offsite livelihood activities which are sometimes in conflict with each other. Even though fewer and fewer households consider Kole as their exclusive source of livelihood, it does not reduce the pressure on the resources but exposes it to different types of interrelated pressures which are very complex to understand. In such a situation, there is a need to disentangle the complex web of interrelated pressures on this wetland ecosystem beyond its significance in supporting the local land based livelihoods alone.

Sakthimurugan (2009) studied the groundwater scenario, management strategy, groundwater related issues and problems in Thrissur district. He has evaluated various hydrometeorological parameters of the district, different aquifers,
groundwater resources, groundwater quality, water conservation and artificial recharge etc. He has identified the over exploited blocks in the district and recommended suitable remedial measures.

Sivaperuman and Jayson (2000) studied the bird’s community of Kole wetlands in Thrissur District. The importance of this wetland as the “stepping stone” for the trans-continental migrants was also discussed. Wetlands in Kerala come under Central Asian-Indian Flyaway (Anon, 1996). Kole wetlands are one such area with much importance. The name Kole refers to the peculiar type of cultivation carried out from December to May and this Malayalam word indicates bumper yield of high returns in case flood do not damage the crop (Johnkutty & Venugopal, 1993).

Sunitha et al (2010) attempted an assessment on impacts of quarrying and crushing activities on the socioeconomic, cultural and health status on quarry workers and non quarry workers (inhabitants) in the surrounding area of Bangalore Metropolitan region. They have carried out in 12 villages where 310 people were involved in the activity. A well structured questionnaire was framed to gather the information on population, sex, literacy, occupation, migration, religion, socioeconomic, living status, assets owned, medical facilities etc. of the quarry workers and non quarry workers. The projected population indicates a positive growth of population with each successive decade. The increase in the decadal population is mainly due to the migration as the granite quarrying is an industrial enterprise and a source of employment. The male population has dominated in the quarry activities over the female population. The living status of the quarry workers is very poor. The health status of the workers reveals that the workers are more prone to respiratory diseases like asthma, tuberculosis, and other diseases like dermatitis, cardiac related, eye irritation, lung cancer etc.,. The livestock showed the symptoms of deafness, debility, infertility and nutritional problems due to ingestion and inhalation of dust. The high rate of miscarriages, still births and premature deliveries among the cattle attributed towards the noise pollution.

Oguntoke Olusegun et al (2009) have monitored levels of suspended particulate matters in the ambient air in and around selected quarries in Nigeria and analyzed the prevalent health problems suffered by nearby residents and quarry workers. It also assessed the residents’ awareness of the negative implications of
living in close proximity to quarry sites. Suspended Particulate Matter (SPM) meter was employed to monitor the level of particulate matter (PM10) within and around five quarry sites selected for this study. The data collected from hospital records of quarry workers portrayed their health profile while the prevalent health problems of the nearby residents were elicited from a questionnaire survey conducted in two selected neighbouring communities of quarries. Results of the study showed that the highest mean SPM levels among the selected quarries vary between 26.03±1.36mg/m$^3$ and 11.03±1.52mg/m$^3$. SPM levels declined significantly (p>0.05) with distance from the drilling and crushing locations at each of the quarry sites. At 25metres away from the quarry sites, mean SPM levels reduced drastically to 4.85±0.20mg/m$^3$ and 3.67±0.40mg/m$^3$. Both psychological and health problems suffered by nearby residents include shock (46.0%), nasal infection (29.2%), and asthma (4.6%). The quarry workers suffered predominantly from cough (26.0%), catarrh (20.0%) and sinusitis (15.0%). Although, the residents of neighbouring communities are aware of risks associated with living near quarry sites, their general low socio-economic status made them incapable of taking any decisive measure towards relocating elsewhere. Approval for quarry operation should mandate environmental impact assessment and ensure strict implementation of outlined mitigation measures so as to guarantee environmental sustainability.

The Technical Committee Constituted by Government of Kerala (2009) have studied the mining/quarrying operations in Kerala with special focus on safety, environmental issues, manufactured sand production and boosting of revenue to Government. The Committee have given predominant importance to the safety of quarries and suggested many mitigation measures.

Department of the Environment, Heritage and Local Government, Ireland (2004) provides guidance to planning authorities on planning for the quarrying industry through the development plan and determining applications for planning permission for quarrying and ancillary activities. The document deals with practical guide to the implementation of section 261 of the Planning and Development Act, 2000, economic importance of quarries, environmental impact and community consultation.
Missouri Department of Natural Resources (2008) have prepared a guide to Environmental Compliance and Pollution Prevention for Quarries in Missouri. The guide sheets provide basic information about regulatory requirements and suggestions for protecting quarry owners and the workers and the environment. Each guide sheet in this publication deals with a separate issue that rock quarries may face.

Surender Singh Chauhan (2010) describe that mining is essentially a destructive development activity where ecology suffers at the altar of economy. Unfortunately in most regions of earth, the underground geological resources (minerals) are superimposed by above ground biological resources (forests). This is particularly more prominent in India. Hence mining operations necessarily involves deforestation, habitat destruction and biodiversity erosion. The extraction and processing of ores and minerals also lead to widespread environmental pollution. However, mankind also cannot afford to give up the underground geological resources which are basic raw materials for development. An unspoiled nature can provide ecological security to people but cannot bring economic prosperity. Scientific mining operations accompanied by ecological restoration and regeneration of mined wastelands and judicious use of geological resources, with search for eco-friendly substitutes and alternatives must provide the answer. A case study of Bijolia Mining area in Rajasthan, India, gave some sensational revelation of the impact of mining on human ecosystem.

Paul Younger and Christian Wolkersdorfer (2004) examined the mining impacts on the fresh water environment. The describe that mining almost always impacts upon the natural water environment, and its effects may be manifest throughout the mine life cycle. The impacts can be beneficial. For instance, some mine waters are of good enough quality that they can be used for public supply (Banks et al. 1996). Beneficial impacts are non-contentious, and thus require little further discussion. On the other hand deleterious impacts, such as depletion of water resources by dewatering, or the pollution of surface watercourses by poor quality mine waters and mine waste leachates, demand careful scrutiny. Because some of these impacts can persist for centuries and even millennia after mine closure, routine approaches to the management of industrial discharges may not be wholly suited to
regulation of the impacts of mining on the water environment. This document provides guidance on approaches to catchment scale water management which are appropriate to mined environments. However, first an overview of the ways in which mining affects the water environment is warranted, and is presented in the first section of the report.

Centre for Water Resources Development and Management (1996) carried out an EIA of Kerala community irrigation Project. The study focused on the environmental impact of the Kerala Community Irrigation Project (KCIP) on shallow aquifer, deep aquifer, river flows, groundwater quality due to application of fertilizers and pesticides, soil erosion, soil quality and human inhabitant in general in Thrissur District. A number of mitigation measures were also suggested to overcome the negative impacts of KICP.

Land environment, environmental issues, landuse changes, mining, soil erosion, soil quality deterioration, environment and health, wetlands etc of Kerala have been dealt in the study carried out by the Kerala State Council for Science, Technology and environment (2007)

Bricks and tiles have been used for building construction for many thousands of years. The word 'brick' has come to suggest solidity and performance. Essentially, the story of brick building is the story of finding good quality brick-making earth in places where there is lack of other building materials like wood and stone (Hayward, 1978). Brick and tile making may be found in most of the countries and the clays suitable for their manufacture are associated mainly with geologically recent deposits. Good deposits of tile and brick clay are found in gently rolling hills (ILO, 1984). A micro-level survey of literature reveals that, although many studies are available on the technological and economical aspects of tile and brick making (United Nations, 1978; Powell, 1980; Keddie and Cleghom, 1980; and many others), not much information exists on mining and related environmental problems of tile and brick clays. Different varieties of clays are found in nature - china clays, ball clays, fire clays tile/brick clays (heavy clays) etc. Among the clay producing States of India, Kerala, probably, ranks at the top. The State contains vast reserves of almost all the above types of clays. Many studies are available on the china clay, ball clay and fire clay resources of Kerala. But not much information is available on the
tile and brick clay resources, although the mining of these clays triggers many environmental problems, especially in the midland and lowland regions of Kerala. (GSI, 1976; RRL, 1989; Soman, 2002).

Among the studies available, the most notable one is made by Kerala State Land Use Board (KSLUB, 1981a&b). KSLUB made a detailed survey in Thrissur and Thiruvananthapuram districts to know the impact of tile and brick clay mining on the fertility/agricultural activities of the respective areas. At that time, the mining activity was not so widespread and did not create serious concern, as the quantity of mining was very limited. While preparing a report on the conversion of paddy land in the State, the Kerala Statistical Institute (KSI) made a systematic documentation of the area affected by tile and brick clay mining in various districts of Kerala. They found that Thrissur is the worst affected due to mining (KSI, 1994). Later, Resmi (1996), in connection with her Master of Philosophy dissertation work, made a detailed analysis of various externalities involved in tile and brick clay mining of Thrissur district. In another study, Pronk (1997) made a systematic documentation on the changing land use pattern with special emphasis on the motives and consequences of clay mining and brick producing industries of Thrissur district. CESS (1999) in connection with the Carrying Capacity studies, documented the tile and brick clay mining and related issues of 'Greater Kochi Region'. In a more recent study on the evolution of South Kerala Sedimentary Basin (SKSB), Nair and Padmalal (2003) made an attempt to unfold the origin of tile and brick clays of SKSB, located between Kollam in the south and Kodungallur in the north. V.Santhosh (2007) assessed the environmental impact of tile and brick clay mining in Chalakkudy and Periyar River basins of Central Kerala. He examined the mining impact on land, water resources and the socio-economic conditions of the study area. He has proposed certain environmental management practice also.

The previous workers have not attempted to analyse the progressive development of quarry/mine and associated land degradation and other environmental impacts using the integration of multitudate satellite imagery and other thematic layers on a GIS platform. The present study deals with environmental impacts of small scale mining/quarrying which had commenced from time immemorial without any initial Environmental Impact Assessment study. Attempt
has been made to quantify the total volume of earth material removed from the study area during different periods. The multi-disciplinary database generated on a GIS platform will immensely help planners and industrial investors in Mukundapuram taluk.