CHAPTER II
REVIEW OF LITERATURE

2.1. INTRODUCTION

The present chapter is synthesis of the problem and analysis drawn from a careful review of literature related to land and water resources, land evaluation, land use, land units, land system, land capability, land degradation, land suitability classification, conservation and so on. All relevant literatures in these lines were reviewed to understand the relative position of land classification and land use planning in several countries that had been adopted and also to draw lessons for India to implement it without hindering the present state of environment. A detailed review of literature related to International and National scenario are brought out under the succeeding paragraphs.

2.2. INTERNATIONAL SCENARIO

Aitchision et al. (1968) stated that the history of terrain evaluation was developed in the United States of America, England, South Africa and Australia. Terrain evaluation is a technique that integrates land resources, mainly surface materials, soils, water and vegetation on a common platform. Evaluation is defined but expresses a continuous change, both of its physical characteristics and also socio-economic conditions.

David et al. (1968) mentioned that the process of land evaluation could be further facilitated, if an integrated picture of the total resource was available.

Frank et al. (1968) describe the three basic stages in land evaluation:

The First Stage: Receiving of stimuli, this is the physical reaction of a body to external conditions;
The Second Stage: Elucidating the received stimuli, ascribing meaning to them (or) recognising whatever caused them; and

The Third Stage: Interpreting the phenomenon, which has given rise to the stimuli, relative to some purpose of the interpreter. There is significant amount of literature dealing with land suitability assessments.

Hopkins (1977) reported a comparative evaluation of alternative methods of assessing land use suitability. There is significant amount of literature dealing with land suitability assessments.

Collins et al., 2001 define Land-use suitability analysis is a multicriteria evaluation, which aims at identifying the most appropriate spatial pattern for future land uses according to specify requirements, preferences, or predictors of some activity.

Dent and Young (1981) define Land Evaluation as the process of estimating the potential of land for alternative kind of use. These include productive uses, such as arable farming, live stock production and forestry.

Fundamental to evaluation is the fact that different land uses have differing requirements. LE needs information from three sources, namely, land, land uses and socio-economic environment. Data on land can be obtained by natural resources survey, on land uses can be obtained from a number of disciplines such as agronomy, forestry, geography and other relevant disciplines and on socio-economic environment from an in-depth field survey. They speak of three types of Land Evaluation: a qualitative evaluation in which the suitability of land for alternative purposes is expressed in qualitative terms only, a quantitative physical evaluation which provides quantitative estimates of the production or other benefits to be expected and an economic evaluation which includes results given in terms of profit and loss, for each specified enterprise on each kind of land.
A further distinction in types of evaluation is between current and potential suitability refers to the value of the land in its present condition, without major improvements. Potential land suitability refers to the value of the land at some future date, and when major land improvements have been carried out.

The FAO of the United Nations has made a commendable contribution to LE by providing a framework, which is simply known as the FAO Framework. This framework induced interest among scientists from various disciplines and this interest has increased rapidly in the recent decade.

Beek 1980 points out, in the FAO Framework, the process of LE is treated systematically against the background of a land use system (LUS) which has been subdivided into a physical land constituent mostly described by land evaluators in terms of land (mapping) units (LU) and a land utilisation type (LUT). This approach makes possible the prediction of the performance of present and alternative land use systems representing different land units and land utilisation type combinations.

Hewitt and Wambeke, 1982 has effectively introduced the land evaluation which is being carried out today. There are three important components: people, land and land use. The interactions between them are:

1. People manage land and land uses and affect the relation between the two.
2. Land, land uses and the interactions between them have a social impact on people.
3. Land suitability determination is a matching exercise in which suitability is matched with alternative land uses.
Meijerink, Valenzuela and Stewart, 1988 have Land Information Systems (LIS) are being developed in various parts of the world, including India. ILWIS – Integrated Land and Watershed Information System of the ITC, the Netherlands, is the best example in which automated land evaluation takes advantage of the Land Evaluation Computer System (LECS) to assess suitability for specific kinds of land use by comparing land qualities with the requirements of the particular type of use. LECS has three modules: the first is used for data entry, validation of the agro-ecological inventories; the second covers the analysis of the agro-ecological land potential in terms of crop suitability and soil degradation hazard and the third introduces management and economic considerations to assess agro-economic crop suitability and feasible soil conservation management options.

Young, 1977, points out, The Framework was designed mainly for use in developing countries. There are six basic principles to land evaluation which are elaborated later in the chapter for clarity:

1. Land suitability is assessed for specified kinds of use.
2. Evaluation requires a comparison of benefits obtained with inputs needed.
3. A multi-disciplinary approach is required.
4. Evaluation is made in relevance to local or national conditions.
5. Suitability is for use on a sustained basis.
6. Evaluation involves a comparison of two or more kinds of use, which are not exclusively agricultural.

Ignatyev (1968) describes the approach to land evaluation for agriculture in the former USSR. The classification of land is by the landscape approach, mainly as integrated systems, but in some areas as separate soil, vegetation and physiographical surveys. Various applied maps were prepared by grouping of categories that showed similar response to particular type of land use.
Mabbutt (1968) reviews the various approaches to land classification. The genetic approach led to large scale and complex classifications, which are unsuited to land evaluation. This type of approach is still essentially at the research stage and they stress that:

a). The relationship between the activity and various terrain parameters must be established before the evaluation process can begin;

b). Terrain classification should be carried out after the model and classification classes have been formulated; and

c). Once the user requirements have been identified, the terrain evaluation has no freedom of choice in the selection of the terrain parameters or in the class units of each parameter.

Robertson et al. (1968) points out that land evaluation has been receiving the assessment of land quality for primary production, specify their users as a development organisation and not the individual farmer and appear to be primarily concerned with irrigated agriculture. There is need for three levels of information and assessment in:

First-stage regional surveys where available information is not sufficient to dedicate the possibilities for agricultural, for example, land system surveys.

Second-stage surveys should provide sufficient data. Apparently, landscape approach classification. Socio-economic and natural factors must be taken into account in the decision also.

Third-stage or detailed surveys are for project plan formulation and cost benefit assessment. It is a parametric land classification. The system includes the estimation of economic inputs and outputs of crop production as well as cost of development of the project.
Young (1968) has conducted the natural resources survey for land development. Young (1973a) has analysed soil survey procedures in land development planning. Young (1973b) has also described rural land evaluation. Young (1975) has defined the crop land relationships and the nature of decision making in land uses the FAO, expert consultation, and land evaluation methodology of Rome.

Bennema (1976) states that the land evaluation is never an aim in itself but always a part of a wider enterprise. Land evaluation is used as a basis for land traction and plays an important role in developing proper land use plans for efficient land development and management.

MacGregor (1977) has evaluated the land use capability map series for Scotland. Land Evaluation has been developed from soil survey interpretation and land use classification. The terms ‘land evaluation’ and ‘classification’ acknowledge that their object of study is land: soil survey interpretation suggests that the soil is the main object of study and the study is restricting itself to the prediction of soil performance. Burrough (1975) has used overseas methods of land evaluation and soil conservation measures.

Several systems of land evaluation are used in soil survey programmes, the most used being land capability classification (Kingebiel and Montgomery, 1986, and soil productivity and potentiality for land evaluation.

The FAO programme of land evaluation is employed to evaluate the soil of the area to know their suitability from growing sorghum crop. (Riquier et al., 1970; FAO, 1976). The FAO of the United Nations has also made commendable (Sys, 1975, 1976, 1978) work on land evaluation by providing a framework, which is simply known as the FAO framework. This framework has induced interest among scientists from various disciplines and the interest has increased rapidly in the recent decade.
The FAO framework (FAO, 1976) has been preceded by a background document (FAO, 1972), and proceedings of the two meetings of the International Expert Consultant Groups (Brinkman and Smyth, 1973; FAO, 1975; also see Stewart, 1968). Many countries have evinced interests in the land evaluation, and pilot studies have been undertaken in Mayawi (Young and Goldsmith, 1977), the Sudan (Van der Kevie, 1976), which show the development of the framework in its final form. There has been a constant change in the framework and this change can be seen in the several reports of the FAO that followed the publication of the FAO framework in 1976.

The alarming rise in the growth of population in developing countries has created an ever-increasing demand for cultural land, grazing, urban development, forestry and tourism, leading to a conflict over land use. Even where land is plentiful, many people may have inadequate access to land or benefits from its use. Intensive use of land and water resources without anticipating the consequences such as land degradation leading to irreversible damage may be clear for all to see, but individual land users may lack the resources or incentive to stop it. Land use planning is a systematic way of addressing these problems. Its focus is the evaluation of land and the options for land use; their purposes to select those combinations of land and land use that will best achieve our goals (FAO 1989).

Kachhwaha et al. (2000) has suggested alternative land use practices for sustainable rural development. Watersheds are the natural hydrologic entities that cover a specific area expense of land surface from which the rain fall run of flow to a defined drain at any particular point. The site of watershed is of practical importance in land and water resources development, because it is considered as more efficient and appropriate unit for survey and investigation for the assessment of these resources and subsequent planning and implementation of various developmental programmes. The watershed approach for developmental activities is more rational because the land and water resources
have optimum interaction and synergetic effect when developed on watershed basis. The watershed approach is therefore, increasingly being employed in various developmental programmes like soil and water conservation, command area development, erosion control in catchments of rivers, dry land/rain fed farming and reclamation of ravenous lands.

On the basis of action plan key, various thematic maps have been integrated and analyzed for preparation of action plan for land resources development. Land use/land cover maps have been used as the base and other thematic maps were overlaid on these maps. All the wasteland and sub-optimally utilized land were then identified and on the basis of land capability and other related parameters, several packages of practices have been recommended to optimally utilize such land on a long term sustainable basis (Krishna Murthy et al. 1997).

Driesen (1986) has described Quantified Land Evaluation, expressed land qualities and land utilisation requirements as numerical variables with values that depend on the momentary state of the land use system. Realistic descriptions of land use system have to be dynamic and also considers biotechnical and socio-economic processes as one integrated whole in the analysis.

Lawrence, et al. (1986) has effectively used air photos in land evaluation in the western highlands of Scotland. Wim et al. (1986) has described the land capability assessment for small holders settlement scheme, in Jamaica in the West Indies. Pettapiece (1987) described the land capability classification for arable agriculture in Alberta.

Dent et al., 1977, has critically looked at the failure of land evaluation, as neither project has ever been used for planning purposes in Nepal or Indonesia. He has been able to pinpoint the lacunae.

1. They do not consider the value of land for purposes other than their stated objective (Masserchmidt, 1985);
2. The land evaluations are biased against socio-economic factors affecting land use decisions (Van Diepen, 1983; Smith, et al., 1984); and

3. The identification of crop constraints does not relate to resources as they exist in the field but they are examined in terms of their potential for modification (Bleeker, 1984).

These criticisms add up to a clear demand for land resources to be evaluated in terms of their biosphere capacity, the socio-economic constraining the development and the means (labour or other inputs) available for changing land use practices. Fox himself has his own criticism, not of land evaluation but of the FAO method, which is a top-down approach that attempts to identify agricultural practices (crop, cultivation practices, conservation measures) that are productive as well as sustainable. In his opinion, the experience has been that the top-down approaches inevitably fail because of the inevitability to stimulate all of the static as well as dynamic variables offering farmers’ land use decisions. Fox has presented an alternative approach that could avoid strategic leaps and grandiose plans and has sought instead to make incremental improvements in current land use practices.

This alternative approach requires:

- Small improvements that seldom involve capital inputs (little need therefore for outside funds or the advice of outside experts);
- Moderate improvements in current practice to bubble up an entrepreneurial fashion in the lower ranks; and A great deal of low-level expertise.

Land classification, even with this alternative, continues to be important, as this approach stresses the need to work with the farmers. There is need however to keep the land evaluation procedure simple so as to assist farmers or extension agents to identify alternative cropping practices.
According to Wambeke (1987), land evaluation is ranking of a set of land units on the basis of their capacity to provide for, under given circumstances, levels of management and socio-economic conditions, the highest returns from an operation per unit area and labour or capital conserving the natural resources for future use. Land evaluation by this definition is tied to a set of land units. It is valid only under well-defined social and economic conditions and determines the nature of land management. Ranking of land units is a relative one, placed however in a broader perspective of conservation of resources for future use.

Australia has provided a changing image of land evaluation. The earliest interest is shown in Stewart (1968). Australia uses a land systems approach to land evaluation. Commonwealth Scientific and Industrial Research Organisation (CSIRO) has been very actively involved in land evaluation research, with a large number of integrated surveys (Bleeker and Laut, 1987). The technique of CSIRO is primarily of value in areas for which there is a lack of soil, geology or vegetation maps (Burrough, 1975). Criticisms of the land systems method centre around the difficulties of identifying recurring patterns on an objective basis as well as upon the purity of ultimate mapping units (Devidson et al., 1982; see Vink, 1975; Dent and Young, 1981). There is an alternative view that the method can be refined so that subjectivity and variability can be reduced and controlled.

A British Organisation that carried out international studies of land evaluation is the British Land Resource Centre (BLRC). For long, the BLRC has conducted surveys of the broad inventory type, an approach based on the land systems approach developed by CSIRO in Australia. The project has been a good, demonstrative model of how the land system approach can be developed to provide the basis for an intense land resource analysis at the regional scale. In later studies, however, the BLRC has gone in for a flexible approach, with area specific, product-specific or function-specific land evaluation procedures, with
a view to developing a generalised problem solving oriented approach on a flexible basis and it is typified by the recent BLRC projects.

Land evaluation has also been used in advanced countries such as Canada and USA. Land evaluation programme in Land Resource Research Centre, Ottawa began in 1976 as an expansion of the Canada Soil Information System (CANSIS) activities. At the time, there was no other model for land evaluation than the FAO framework but this appeared suitable for regions with non-industrialised agriculture and with limited information (Dumanski, MacDonald and Huffman, 1987: 24). In the year 1977, a National Work Planning Meeting was held to generate a number of recommendations for land evaluation in Canada (Halstead and Dumanski, 1977). These emphasised the development of appropriate methodologies, with focus on the ability to consider and manipulate inter-relationships between the environment and the economy in dynamic rather than static (classification) sense.

The fundamental purpose of LE is to predict the consequences of change. In determining the potential for alternative uses, the primary purpose is in defining land suitability. The concept of land suitability, for example a particular crop or cropping system, is complex, because suitability has to be assessed for sustained production in a rational cropping system (FAO, 1976).

Anderson (1987) surveyed different methods of land capability/suitability analysis ranging in degrees of computational and analytical sophistication. Land evaluation is a procedure that involves a lot of information which is distinguished by its geographic and multivariate character (FAO, 1996).

Furthermore multicriteria evaluation may be used to develop and evaluate alternative plans that may facilitate compromise among interested parties (Malczewski, 1996). In general, the GIS-based land suitability analysis assumes that a given study area is subdivided into a set of basic unit of observations such
as polygons or raster. Then, the land-use suitability problem involves evaluation and classification of the areal units according to their suitability for a particular activity.

Geographic information systems (GIS) serve the multi criteria evaluation function of suitability assessment well, providing the attribute values for each location and both the arithmetic and logical operators for combining attributes (Jiang and Eastman 2000).

Land-use suitability mapping and analysis is one of the most useful applications of GIS for spatial planning and management (Collins et al., 2001; Malczewski, 2004).

The potential of land for agricultural use is determined by an evaluation of the climate, soil and topographical environmental components, and the understanding of local biophysical restraints (Ceballos-Silva and Lopez-Blanco, 2002). This evaluation is an essential step for sustainable cultivation in the area by integrating various kinds of information with spatial analysis technique. Geographic Information System is an organized collection of computer hardware, software, geographic data and personally designed to efficiently capture, store, update, manipulate, analysis and display all forms of geographically referenced information (ESRI, 1996). GIS has the ability to perform numerous tasks utilizing both spatial and attribute data. This powerful tool allows decision markets to simulate effects of management and policy alternatives within a geographic area prior to implementation. Also, GIS is a tool that can be used to predict alternative crop growth and yield (Ghasemi Pirbalouti et al., 2008) of medicinal plants. It is necessary to assess the land suitability for medicinal herbs cultivation.

Teka and Haftu (2012), have evaluated each piece of total land of Korir watershed, Ethiopia to assign the suitability for different crops and fruits commonly grown by the local farmer and recommend these results to the local
stakeholder for an increased yield. They have focused on food crops and fruits, which can be used to alleviate poverty and improve nutrition in farm households.

The importance of landuse studies has gained momentum only after the first comprehensive survey of landuse in Great Britain by Stamp in 1930. The integrated resources survey provides knowledge of the potential available resources which is essential for formulating and executing effective management strategies for their proper utilization. Developmental planning with integrated approach has been accepted world over as a means to optimize and sustain output from primary system to meet the growing demands of ever increasing population. To meet the requirement of this increasing population and to achieve sustainable development, it is essential to check over exploitation of natural resources on one hand and optimal utilization of land and water resources on the other hand by understanding the mutual interdependence of these resources based on scientific approach (Khan, 1998). For scientific management of natural resources, it is essential to integrate the data of various land and water resources together with the data on socio-economic condition, for optimal utilization of these natural resources. This proves lands to the generation of area specific action plan.

Topographical map and remote sensing data were used to analyse the change. Suwanna (1994) used a time series data of 1973 to 1991 to detect changes. Multiple regression analysis was applied to find out impact of landuse change on stream flow and suspended sediments. Joshi and Suther (2004) used time series analysis to study about the changing urban land use and its impact on the environment. Uraiphan (1988) used to graphical map, Landsat images and aerial photographs to conduct a time series analysis of land use change. Berka et al (1995) used GIS techniques for analyzing the linkage between landuse and water quality.
Stoorogel (1995), for purpose of land use planning in a Costa Rica rural settlement, links external biophysical aspects with a Geographical Information System (GIS), applying linear programming for the analysis of alternative land uses at the farm and field level.

The land use change affects the quality of the environment, mainly the hydrological system and soils. Stream flow change is most significant in most of the recent major irrigation projects due to deforestation in the catchment (Amarasekara, 1994). Another study by Williams et al (2003) revealed the adverse impact of land use change on the hydrological response of the river Camel in United Kingdom. Impact of land use change on natural hydrological system was also pointed out by Joshi and Suthar (2004). A study by Suwanna (1994) in the Pasak basin brought out that the decrease of forest in the upper parts of basin causes depletion of stream flow quantity and suspended sediments.

Iverson (1998) found only a moderate correlation between landscape attributes and land-use change in Illinois, but the relationship was stronger in natural land types, such as forest and agriculture than in more human manipulated landscapes, such as cities and towns. Domon et al (1993) discovered that land owner perception and attitudes, government programmes polices and biophysical characteristics all influence land owners in a agro forestry landscape.

Another major impact of land use change is its impact on water quality. Berka et al (1995) analysed water quality according to land use change and found that the quality of water changes with land use type. Increased fertilizer usage in the last three decades in the developing countries caused nitrate contamination in groundwater (Keeney, 1989; Chilton et al., 1994). Charbonneau and Kondolf (1993) assessed the impact of agricultural land-use change on non-point source pollution in rural California.
Mertons and Lambin (2000) found out that forest cleared for crop land in Cameron was linked to accessibility rather than to soil productivity.

A temporal analysis of land use change on the South Downs in Sussex, United Kingdom was carried out by Burnside et al (2003). He has used a time series analysis using aerial photographs and GIS techniques to analyse the change. Acevedo et al., (1997) conducted a time-series analysis to understand the urban land use change in the Las Vegas valley.

Karkaj et al. (2012) has defined landuse planning as the process of determining the best use of the land according to its ecological and socio economic characteristics. They have conducted landuse planning of the Chehel Chay watershed in north of Iran. They have implemented that determination of priorities for appropriate landuse from ecological thematic maps cannot be adequately precise without considering the socio-economic condition of the area or the tendency of the area residents to utilize the land for certain specific uses.

Studies on drainage basin characteristics were contributed by Horton (1945; Smith, 1950; Strahler, 1957). Strahler (1964) pointed out that the shape of drainage basin would conceivably affect the stream discharge characteristics. Horton (1932) introduced a quantitative expression of drainage basin shape through form factor, Schumn (1956) used elongation ratio and Miller (1953) used circularity ratio to describe the basin shape. These indices are highly helpful in understanding the watershed characteristics and to suggest appropriate conservation measures. Mishra et al., (1984) analysed the effect of different topographic elements and sediment production rate of sub- watersheds in the upper Damodar valley. They have concluded that increase of factor reduces the sediment production rate.

Islam M. Faisal et al. (1997) in their study to solve long- run ground water management problems in Denver basin, Colorado, US. They have made use of the Discrete Kernel- based aquifer model and conjugate gradient- based
nonlinear programming. This method is found to be capable of handling very large problems when simple operational objectives are used and economic considerations are perhaps relegated to a separate economic sub model.

Hong-II Ahn and Hyo-Taek Chon (1999) have investigated geochemical contamination of ground water and spatial relationship in Asan area (Agriculture area) and Gurogu (Industrial area) of Seoul, South Korea using GIS. In this study two sites were selected in order to investigate groundwater contamination and spatial relationship among groundwater quality, topography, geology, land use and pollution source. One site is in the Asian area, an agricultural district where pollution sources are scattered and which is mainly underlain by granite of Cretaceous age. The other site is the Gurogu area of Seoul city, an industrial district where industrial complex and residential areas are located and which is mainly underlain by gneiss of Precambrian age.

Admat et al. (2003), has attempted to produce groundwater vulnerability and risk maps using GIS for the Basaltic aquifer of the Azaraq basin, Jordan. These maps are designed to show areas of greatest potential for groundwater contamination on the basis of hydro-geological conditions and human impacts. All the major geological and hydro-geological factors that control and affect the groundwater movement of the study area were incorporated into the model.

Ochola and Kerkides (2003) studied the development a spatial decision support system for water resource management in Kenya. In their model they integrated the biophysical, socio-economic aspects of land water use for the identification of sustainable water use practices. The GIS integration is observed to have enhanced its ability to guide land and water use for the identification of sustainable water use practices. The GIS integration is observed to have enhanced its ability to guide land and water use decision making by setting best water use guidelines and deciding on the most appropriate spatial strategies. The system is found to assist land and water use planning through the evaluation of
sustainability of water resources, identifying environmental issues concerning future water use sites and defining the conditions for use of present water resources.

Aiyesanmi et al (2004), has carried out the geochemical characteristics of groundwater with in Okitipupa, bituminous sand fields of Nigeria. Most of the groundwater samples were found to be of low pH; while other physicochemical parameters, including some heavy metals measured showed varying concentrations ranging between below and above the WHO guideline value. Since the exploration and exploitation of bitumen are yet to commence in this area, the data serves as baseline information on the groundwater quality.

Akankpo et al. (2012) used GIS software. ILWIS 2.1 was used to analyze and create groundwater pollution sensitive zone map for Michael Okpara University of Agriculture Umudike and its environs, Southeastern Nigeria. Spatial variability maps of different groundwater quality parameters were generated using interpolation operation in the software and were incorporated as data layers in the software for further generation of groundwater pollution sensitive zone map.

Agelos, et al. (2010) identified Groundwater quality, using (a) descriptive statistics, (b) t test for equality of cluster means, (c) box plot, (d) error bar, (e) factors score plots, (f) matrix scatter score means plot and (g) scatter plot of the six significant latent factors from the factor set of all samples group in the region of Thessaly, located north of Athens in central Greece.

2.3. NATIONAL SCENARIO

Dhillon (1977) has delineated different landforms and their impact on agricultural land use in Mahasu District of Himachal Pradesh. A micro, village-based study of soil survey land evaluation is that of Jain and Sharma (1978). This is perhaps the earliest of all studies in India. Land capability classification
and land use planning have however been the focus of several studies, with a land system approach to land evaluation.

In India, the only major and regional study is that of land Management for Rural Development in the Kambam valley (Aruchamy, 1986). This study as followed, in general, FAO Framework (the two stage approach) to the rule, with a quantitative methodology developed for land capability and suitability classification. A micro village based study of soil survey and LE is that of Jain and Sharma (1978). This is perhaps the earliest of all studies in India. Land capability classification and land use planning have however been the focus of several studies, with a land systems approach to land evaluation (Singh, 1971).

Land evaluation for Agricultural Land use Planning in Thevaram basin (Jaganathan, 1994) is a study that has followed, in general, the FAO framework two-stage approach, with a quantitative methodology developed for land use requirements and land suitability classification. GIS based land evaluation studies have been made at the Madras University, Department of Geography. There are several GIS applications to land evaluation also by the IRS (Institute of Remote Sensing), Anna University, Chennai and those of the NRSA, (National Remote Sensing Agency), Hyderabad and Indian Institute of Remote Sensing (IIRS) at Dehradun.

Saravanakumar (1996) has under taken a land evaluation study of the coastal zone of the Southern Tamil Nadu for his doctoral research and attempted some newer approaches especially that of Special Area Management (SAM) for land development.

Thangamani (1997) has studied the morphology evolution and evaluation of land and water resources of the Ponnaiyar river basin and has contributed newer perspectives to land evaluation methodology.
Sathy Priya (1997) has effectively used GIS in land evaluation for crop suitability analysis, with a case study of Panchana watershed. The specific objectivities of her study is to create spatial database for land suitability analysis, to develop model for land suitability classification by using GIS techniques and to identify the suitable area for various types of crops.

Land and land cover change are significant to a large number of themes and issues central to the study of global environmental change. Man’s perceptions of his environment and subsequent alterations are manifested in the context of land use (Chattopadhyay, and Nair, 1989). Land cover changes are most often non-continuous in space, leading to complex landscape mosaics and mixtures of cover types.

Reid et al (2000) found that changes in technology, culture, power and political/ economic institutions all have profound influences on land use. Another land-use change study conducted in Malawi, examined land use in areas with particularly high rates of change and interviewed local residents. They concluded that current problems have historical foundations. Political and economic events and trends left an indelible mark on people’s attitude toward natural resources and changed the manner in which their resources were managed (Gumbo et al., 2000). Kulkarni (2001) also emphasizes that growing population along with local government policies and changes in the local economic development and consumption pattern change the existing land use pattern. McCusker (2004) in his study revealed that a land reform problem also causes land use changes.

Rao (1999) has pointed out that in India owing to ever increasing pressure of population on land for meeting the growing demand for food, fuel and fiber, a sizeable area of erstwhile barren, fallow and marginal lands and forests in the country have been brought under cultivation.
The study conducted by Jayakumar, and Arockiasamy (2003) in the Eastern Ghats of Tamil Nadu found under utilization of potential crop land, mismanagement, faulty land use practices, increased population, land conversion, intensive fuel wood extraction and cattle grazing as the major driving forces for the changes in land use during the 10 year period.

Sikka (1977) found that Rainfall is one of the most governing factors in planning the agricultural program for any area. Monsoon depressions and cyclonic storms are the most important synoptic scale disturbances which play a vital role in the space–time distribution of rainfall over India.

Umamathi and Aruchamy (2012) have effectively used GIS techniques for Rainfall Rhythm of Surili AR Watershed, Tamil Nadu. The rainfall is primary source for water and it is characterized by its amount, intensity and distribution in time. The study could form a basis for planning the agricultural activity of the study area. In order to understand the spatial pattern of annual and seasonal rainfall, their variability, precipitation ratio and frequency occurrence of rainfall have been analysed through GIS environs.

Thilagavathi et al (2014) has adopted Rainfall variation and groundwater fluctuation in Salem Chalk Hills area, Tamil Nadu, India. Rainfall is a distinctive variable. It reflects influence of multiple meteorological factors locally and globally. Long term rainfall data in respect of Chalk Hills (Magnesite mines) area, Salem have been analysed. From this analysis, an increasing trend in the rainfall from January to May and declining trend in the rainfall during May and June are noticed. Groundwater level fluctuation analysis shows that some of the places have deeper water levels during southwest monsoon season. Groundwater starts to replenish the shallow aquifers during northeast monsoon season and reaches high during post-monsoon period when plants are dormant and evaporation rates are less. The water levels remain stable only up to
November but during January to May, the water level declines gradually due to water extraction for irrigation.

Beyond agriculture, other drivers of land use change include industrialization and urbanization, which may further degrade natural resources and the environment. A study conducted by Tri-Academy in many regions of the world (INSA, 2001) revealed that although initially it was assumed that population growth alone might be a significant driver of land use change in many of the regions, the results indicated that many other factors also played important roles in the transformations. These factors include government policies, changes in consumption patterns, and the effects of economic integration and globalization.

Ramakrishnan (2001) pointed out that in Kerala, although fast-rising population is considered to be the basic measures of land use change other factors like government policies, directly or indirectly, cause land use change. Policies that have affected land use include environmental policies, population policies, foreign investment regulations, economic price controls on agricultural inputs outputs, resettlement incentives, taxation privatization and reforestation programmes.

There are many other case studies concerning agricultural nitrate pollution within India (Kumar, 1983; Kakar, 1985). Soman et al (1997) linked land use and river water pollution in south Kerala. Different methods were used to analyse the land use/land cover change ranging from field documentation, time series map analysis to remote sensing.

The soil and land resources assume a more critical role affecting the livelihood of vast majority of populace. In recent years information connected to land resources is becoming increasingly available even though uncertainty remains an issue for information worth in any deterministic methodical framework. In India availability of per capita land is shrinking at an alarming
rate. In 1951 it was 0.90 ha, in 1980 it became 0.5 ha, and in 1955 it became 0.17 ha. Prognostic modelling reveals that by the year 2020 it will be 0.09 ha, i.e. a plot size of 30m x 30m (Narayan, 1996; Sehgal et al., 1996). In effort to use the land, man misused, under used and over used the land.

Watershed Management Programme has emerged as a sustainable strategy to conserve the natural resources i.e. Water, forest and soil in an integrated manner particularly in the rain fed and drought areas. As per an estimate of Government of India out of the total geographical area (329 million hectare), two third (260million hectare) of its area is drought prone and 144.30 million hectare is subjected to degradation due to soil erosion (Wasteland Development Board, 1992). The integrated and holistic approach of watershed development has been focused for sustainable development of the society. The planners, academicians, development professionals, NGO activists, and national and international funding agencies like Government of India and World Bank have led a major emphasis on development through watershed management approach. The people’s participation has been termed as a key to success of watershed development. Sukhomajri Project in Ambala district, Haryana (India) was a turning point for the Gujjars (a nomadic tribe) of Sukhomajri who were living in their traditional way before the watershed project intervention in 1979. They were the poor graziers/ shepherds. Their land was not irrigated and they were dependent on rain fed farming. The forest areas near to village Sukhomajri was highly degraded. Later on successful implementation of watershed projects and creation of water harvesting structures provided sustainable livelihood to the Gujjar families. People of the village organized themselves, gave up grazing as occupation to protect the nearby forest which was highly degraded. This concept was popularly known as ‘social fencing’ (Mishra and Sarin, 1987).

Uniyal and Gupta (2013) have attempted prioritization and morphometric analysis of micro – watersheds for the Bhilangana watershed of Uttarakhand. ASTER DEM m data have been utilised for extracting stream networks of
watershed in Geospatial environ. While considering watershed conservation work, it is not feasible to take the whole area at once. Thus, the whole basin is divided into several micro watershed, by considering its drainage system.

Kumaraswamy et al. (1996) studied the hydro geochemical evaluation of seawater intrusion in the vaippar Estuary, Tamil Nadu and stated that the excessive use of the ground water to supplement the surface water resources has resulted in the intrusion of seawater into coastal fresh water aquifers and made the fertile land unsuitable for cultivation.

Kelly (1940) Wilcox (1995) and Eaton (1950) had proposed certain indices to find out the alkali hazards and residual sodium carbonate (RSC) which could be used as criteria for finding out the suitability of irrigation water. It is felt that by considering the entire chemistry rather than the individual ionic or grouped ionic character in pairs, the results obtained would be better (Doneen 1966 and Handa 1979).

The cropping patterns of a region are closely influenced by the geo-climatic, socio-economic, historical and political factors (Hussain, M.1996). Relating the crop density in each of the component areal units of the region to the corresponding density for the entire region. It makes it possible to measure the regional concentration of crops objectively and to differentiate areas that have some significance with regard to crop distributions within the region (Bhatia, 1965). The study of crop concentration is helpful in many ways in deriving relevant conclusions about crop distribution. Higher the crop concentration index, higher is the level of interest in the production of that crop. It helps in taking important decisions regarding marketing, storage, and trading of the crop produce.

The study of cropping is the most important aspect in the agriculture geography for the rural planner. Bagchi and Jana,1974.In order to understand the concept of combination several scholars have made ceaseless efforts and
introduced a number of statistical methods, for example, Weaver (1954), Doi (1959), and Rafiiulah’ (1956).

Lloyd (1976) attempted to study on hydro geo chemistry and ground water slope pattern in the saidapur Tahsil, Ghazipur District, Uttar Pradesh to find out the chemical variation, He used Durov’s method to differentiate the major ironic constituents of ground water and had also used isotopic analysis to trace the ground water.

Handa (1979) has given clear picture of crop analysis in his attempt on the quality criteria for groundwater. The study has given guidelines of crop to clearance level for different crop by using electrical conductance (EC), Exchangeable sodium percent (ESP) and Boron Concentration and the requirement of the gypsum for the high sodium ware during irrigation.

Ganesh (1985) studied problems and prospects of water resources in the upper Vaigai basin. Since the present study area is part of Vaigai basin, the results of his work was given an insight about water resource potentials in Andipatti watershed. He attempted to study the pattern of water resource utilization and concluded that the groundwater resources in the study area are exploited mercilessly mainly for irrigation. It was recommended that conjunctive utilization of surface and groundwater should be planned for irrigation commands.

Ashok Kumar et al. (1991) have investigated the hydro geochemical characteristics of the area in Munger in the state of Bihar. In this study they have estimated the aquifer and the thickness of various geomorphic unit of the area.

Sridevi et al. (2001) have delineated various hydro geomorphic units and lineaments for the development of groundwater in the Pegeru river basin, Cuddapah district, Andra Pradesh state. The integration of geomorphology and lineament reveals that shallow groundwater occurrences are controlled by
geomorphologic characteristic whereas fault/fracture control the yield of groundwater at intermediate depths.

**Malini et al., (2003)** have analyzed the ground water quality around Mysore, Karnataka. These analyses were carried out on change of ground water quality, rock water interaction and saturated characteristics of geochemical data.

**Vajrappa and Rajadhan Sign (2003)** have applied the statistical factor analysis to study the hydro-chemical data of 95 bore well water samples collected from Suvarnamukhi sub-basin of Arkavathi river, Bangalore District, Karnataka. Factor analysis techniques identified three factors, TDS, carbonate and bicarbonate that accounted for 74.83 percent of the major iron variation observed in the sub-basin.

**Babu and Sankana pitchai (2004)** have studied the hydro chemical characteristics of Brahmanapalle-Vemula mine water, Cuddapah District, Andhra Pradesh State using multivariate analysis. The positive factor loading are found loaded on Mg, K, NO₃, HCO₃, F and negative pH. Strong positive correlation has been observed between TDS and Cl.

**Anbazhagan and Nair (2004)** have developed GIS based ground water quality mapping in Panvel basin of Maharashtra State. The geo- Chemical analysis of groundwater indicates the level of quality for drinking and irrigation purpose. The chemical parameter such as chloride, hardness, TDS and salinity were pictorially represented using GIS. The study has helped to identify the areas which are the areas of basin are suitable/ unsuitable for drinking and irrigation purposes within the basin.

**Devendra Singh et al. (2014)** aimed at assessing the water quality index (WQI) for the groundwater of Doiwala block of Doon valley. This has been determined by collecting legacy data from organization concerned. For calculating the WQI, the following 11 parameters have been considered: pH,
total hardness, calcium, magnesium, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides.

Thus several research workers have attempted watershed based landuse, rainfall, morphometric characteristics and landsuitability analysis for drawing sustainable development plan. Hence, the present study has been conceived to achieve the sustainable development in Koraiyar watershed through by analyzing Land characteristics and existing Lanuse conditions.

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