CHAPTER 2

LITERATURE REVIEW

2.1 LANDUSE LANDCOVER (LU/LC)

Land use and land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to stimulate changes (Prakasam 2012). Urban expansion has increased the exploitation of natural resources and has changed land use land cover patterns. Rapid urbanisation therefore brings opportunities for new urban developments. LU/LC is a major issue of global environment change (Willson 2006, Rimal 2011). Scientific research community called for substantive study of land use changes during the year 1972 (Stockholm conference) on the human environment and again 20 years later at 1992 United Nations Conference on Environment and Development (UNCED). At the same time, International Geosphere & Biosphere (IGBP) programme and International Human Dimension Programme (IHDP) co organized a working group to set up a research agenda and promote research activity for LU/LC changes (Prakasam 2012). Land use refers to man’s activities and the varied uses which are carried-on over the land and land cover refers to natural, vegetation, water bodies, rock, soil, artificial cover and others noticed on the land (NRSA-1989) (Prakasam 2012). Land use includes agriculture land, built up land, recreation area and wildlife management area etc (Prakasam 2012). Mapping is an essential component, where in other parameters are integrated on the requirement basis to derive various development indexes for land and parent water resource.
Land degradation results mainly due to population pressure which leads to intense land use without proper management practices. Remote sensing and Geographic Information System (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modelling (Cheng-fan et al 2011, Irfan, Asadi et al 2007, Ali et al 2006). In water sheds the land use has direct effect in determining water quality. The change in any form of land use is largely related either with the external forces and the pressure built up within the system (Bisht and Kothyari – 2001). UDR programme provides basic data, predictions, and perspectives to help in forming sound policies for guiding environmentally sustainable growth (Willium 1999).

Increasing human population, its greed and its urbanization have increased the land use pattern and land use density. Thus, through the centuries, the nature of the surface and sub surface soil is going on changing due to anthropogenic causes. Similarly limited water resources have been overused / misused by the ever increasing population of the country. The geochemical status of ground water and soil of the part of terrain between Noa Dihing and Burhi Dihing rivers revealed that soil and ground water geochemistry is influenced mainly by natural processes such as geological background, weathering of prevailing geological formation together with impacts deriving from the extended cultivation. (Das et al 2011).

Arya and Abbasi (2001) formed the software package (INTRA-INTer-Parameter Relationship Analysis) for Environmental Impact Assessment. The results on EIA for third world town Roorkee indicated that the population density is highest in hierarchy and has also the greatest driver power. However, autonomous indicators such as temperature and power availability are less influenced by the key actor than several other indicators.
For example, changing population scenario will change the landuse pattern. This in turn, would alter the water level (a dependent indicator).

With an area close to 27 million hectares, a territory being as large as Belgium and Great Britain together is threatened by a major ecological disaster. A modelization of the local desertification is being developed that could be a useful tool to be addressed to the stockholders for a better understanding and finally a more efficient management solution (Hirche et al 2011).

With the increase in urbanization globally, there is an increased need to understand the ecology of forest fragments in urban and urbanizing landscapes (Thompson and McLachlans 2007).

Chen et al (2005) presented the study which focused the concept on impacts of both land-cover change and climate variation on a mesoscale river basins, the Suomo Basin located on the upper reaches of the Yangtze River. He used two models for the study namely Climate and Human – Activities Sensitive Runoff Model (CHARM) and Soil and Water Assessment Tool (SWAT) model. These two models had been compared with new model developed by Beven top model used to stimulate the impacts of climate fluctuation and land-cover changes on the runoff in the Suomo Basin.

Detailed knowledge of the biodiversity of spider communities on agricultural land is important both in terms of enhancing pest control and understanding the driving forces, influencing nature conservation value. (Downie et al 1999).

Wetlands provide many important functions and values in the landscape, including reduction in flooding, fish production, carbon storage (Mitch and Gooselink 1986, Groot 1992, Keddy 2000, Houlahan et al 2006).
Sustainability implies more than environmental or economic well being. It is a fundamental harmony between the two, a concept that may be aptly compared to ‘health’ or ‘balance’, as it relies on the three-legged stool: ecology, economy and society (Blackburn 2003). Ladysz (2006) emphasised on continuation of guidance and financial assistance of the European Union for transforming a landscape.

Jiang (2006) analysed the land use change from 1982 to 2003 using RS and GIS and the impacts of land use changes on pH value, organic matter, total Nitrogen, total Phosphorous, total Potassium, available Nitrogen, available Phosphorous, available Potassium in soil of Xiaojiang watershed, a typical karst agricultural region of Yunnan Province, Southwest China were assessed. The soil properties changed differently, due to the differences in land use change.

Luo et al (2005) studied the dynamic change pattern of sandy desertification from 1993 to 2002 according to different land-use patterns and identified the driving forces of sandy desertification development.

Ciligot and Josselin (2009) developed an approach to assess the sensitivity of centers to different metrics used to locate them, according to various spatial distributions of demands.

Landslide hazard is one of the major environmental hazards in geomorphic studies in mountainous areas. For holding the planners in selection of suitable location to implement development projects, a land slide hazard zonation map has been produced for the Golmakan Watershed as part of Binaloud northern hillsides (northeast of Iran) (Daneshvar and Ali 2011).

Communal Areas Management Programme For Indigenous Resources (CAMPFIRE) is a long-term programmatic approach to rural
development that uses wildlife and other natural resources as a mechanism for promoting devolved rural institutions and improved governance and livelihoods (Taylor 2009).

The current research areas of eco-security problems include ‘state eco-security, agriculture ecological security, land utility and ecological security, nature protection areas and ecological security, water security, resources security, and eco-security systems. Eco-security is closely connected with land use / cover changes (Wang et al 2005).

Due to dramatic Land use/cover changes, especially, the over-exploitation of natural ecosystems such as grass land, forest, and wetland, and changes in component, structure and function of natural ecosystems, habitats are fragmented, natural species are reduced, even died, water is polluted and soil is eroded (Xu 2002, Hou and Cai 2004, Li et al 2005, Zhao et al 2005). Recently, many researchers are interested in the study of landscape patterns of wetlands based on RS and GIS at the landscape scale (Kelly 2001, Liu 2004).

Yasushi and Satoshi (2011) discussed about (LULUC) Land use / Land-use change. The study reviewed that the listed factors determining spatial distribution of LULUC, and categorized them into: (i) socioeconomic factors, subcategorized into accessibility, local community development, spatial configuration, and political restrictions; and (ii) Natural environmental factors, subcategorized into topography and productivity.

2.2 GROUND WATER QUALITY

Rapid urbanization brings with it many problems as it places huge demands on land, water, housing, transport, health, education etc. Fresh water is one of the basic amenities for sustenance of life, the human race through ages has striven to locate and develop it. Water is a vital source of life in its
natural state is free from pollution. But when man tampers the water body it loses its natural conditions. Ground water has become an essential resource over the past few decades due to increase in its usage for drinking, irrigation and industrial uses. The quality of ground water is equally important as that of the quantity (Asadi et al 2007). One of the major direct environmental impacts of development is the degradation of water resources and water quality. Conversion of agriculture, forest, grass and wet lands to urban areas usually comes with a vast increase in impervious surface which can alter the natural hydrologic condition (Tang et al 2005). The problem of drinking water contamination, water conservation and water quality management has assumed very complex shape. Attention of water contamination and its management have become imperative because of far-reaching impact on human health (Sinha and Srivastava 1995).

Ground water pollution not only affects the water quality, but also threatens human health, economic development and social prosperity (Priti and Khan 2011). The urban areas are fast getting densely populated and are expanding rapidly to adjoining areas putting unwanted stress on the natural resources (Pradeep et al 2008). House and Newsome (1989) stated that the Water Quality Index (WQI) allows ‘good’ and ‘bad’ water quality to be quantified by reducing a large quantity of data on a range of physico-chemical variables to be a single number in a simple, objective and reproducible manner (Liou et al 2004). The WQI concept is based on the comparison of the water quality parameter with respective regulatory standards (Khan et al 2003) and provides a single number that express overall water quality at certain location based on several water quality parameters (Yogendra and Puttaiah 2008). WQI improves understanding of water quality issues by integrating complex data and generating a score that describes water quality status and evaluates water quality trends (Boyacioglu 2007). The quality of water is generally defined in terms of its physical, chemical and biological
parameters and measured as water quality index to assess whether water is potable or not. Deeper ground water tapped by bore well can still be used for drinking purposes with caution.

Susanna and Wenli (2002) attempted a Research on modelling the relationship between land use and surface water quality. The research attempted to use a comprehensive approach to examine the hydrologic effects of land use at both a regional and local scale in the State of Ohio. Besides, a widely accepted water shed-based water quality assessment tool, the Better Assessment Science Integrating Point and Nonpoint Sources (BASINS), was adopted to model the plausible effects of land use on water quality in local water shed in the East Fork Little Miami River basin.

Le Blanc et al (1997) concluded his research that run off from highly developed urban areas may be enriched with rubber fragments, heavy metals, as well as sodium and sulfate from road deicers. Moreover, through evapotranspiration, interception, infiltration, percolation and absorption, different types and coverages of vegetative surfaces can modify the land surface characteristics, water balance, hydrologic cycle, and the surface water temperature. Gburek and Folmer (1999) said that there is a strong relationship between land-use types and the quantity and quality of water. In a study of the effects of forested, agricultural and urban areas on water quality and aquatic biota in piedmont eco region of North Carolina, (Lenat and Crawford 1994) found that the agricultural lands produced the highest nutrient concentrations. Fisher et al (2000) also noted a higher amount of nitrogen, phosphorus and Fecal coliform bacteria in the poultry production areas in the Upper Oconee Water shed in Georgia. Bilstad and Swank (1997) observed that there were consistent changes in water quality variables, concomitant with land-use change in the study area Coweeta Creek in western North Carolina. Mander et al (1998) concluded that in Little Miami River Basin, the urban
development in the water shed had caused substantial modification on flood runoff and water quality. Changing land use and land management practices are therefore regarded as one of the main factors in altering the hydrological system, causing changes in run-off. He examined the impacts of land use on only the quantity or the quality aspect of runoff.

Acworth (2009) presented a paper which emphasised the interconnected nature of surface water and ground water in 2009. He said it is clear from policy laid down in the last 20 years that the degree to which surface water and ground water are interconnected has somehow slipped from general awareness. He said groundwater is one word, while surface water is two words! A symptom of divergence that has occurred even the spelling now accepted in common parlance in Australia. Due to the lack of general awareness concerning interconnectivity (Winter et al 1998) prompted to publish a seminar work on Groundwater and Surface water-A Single Resource that has been extensively used by the groundwater community to better understand the problem.

Houtman (2010) suggested the precautionary principle is used to motivate that prevention of emission of emerging contaminants into the environment is the preferred approach to safeguard sustainable drinking water production. In the mean time, extensive monitoring of the sources and development and application of advanced treatment techniques are used to prepare safe drinking water. Field et al (2006) discussed about the REACH (Registration, Evaluation, Authorization of Chemicals; EC 1907/2006) in 2007. To improve the protection of the human health and the environment, the European Commission enforced the REACH which gives a greater responsibility to manufacturers to better and earlier assess hazards and risks of their produced compounds and to identify and implement measures to protect the humans and the environment. REACH thus provides a legislative
basis to investigate toxic properties of compounds before they are applied or emitted into the environment instead of after their emerge as contaminants.

Hack et al (2006) used Component of Community Climate System Model (CCSM) and Community Atmospheric Model version 3 (CAM3). The formulations of processes that play a role in the hydrological cycle are significantly more complex.

The mechanisms of interactions between ground water and surface water (GW-SW) as they affect recharge-discharge processes are comprehensively outlined, and the ecological significance and the human impacts of such interactions are emphasized. However, to advance conceptual and other modelling of GW-SW systems, a broader perspective of such interactions across and between the surface-water bodies is needed, including multi-dimensional analysis, interface hydraulic characterization and spatial variability, site-region- regionalization approaches, as well as cross-disciplinary collaborations (Marios 2002). Larkin and Sharp (1992) suggests that a geomorphologic perspective is also helpful in characterizing largerscale GW-SW interactions and in estimating the extent and location of such interfaces. The author classified stream-aquifer systems (based on the predominant regional ground water flow component) as:

- **Underflow** - component dominated (the ground water flux moves parallel to the river and in the same direction of the flow of steam).
- **Baseflow** - component dominated (the ground water flow moves perpendicular to or from the river depending on whether the river is effluent or influent, respectively.
- **Mixed.**
Beven and Germann (1982) defines interflow as the near-surface flow of water within the soil profile resulting in seepage to a stream channel within the time frame of a storm hydrograph. He assessed the Rapid subsurface responses to storm inputs which may be the result of fast flow through larger non capillary soil pores, or macropores. The results from environmental-isotope studies (Sklash and Farvolden 1979) indicate that interflow may be primarily displacement process in which the storm rainfall induces the displacement of subsurface-stored water (pre-event water). He described the ground water ridging is the large and rapid increase in hydraulic head in ground water during storm periods. He further explained that an assumption is made that water do not enter a large non capillary pore unless it is at or above atmospheric pressure. Such conditions only occur either below the water table or after ponding during rain fall at the soil surface.

Borja et al (2000) proposed a marine Biotic Index (BI) for soft-bottom benthos of European Estuarine and coastal environments. A validation of the proposed index is made with data from systems affected by recent human disturbances, showing that different anthropogenic changes in the environment can be detected through the use of BI. Lenat (1988) discussed a standardized qualitative sampling technique which was developed and tested for shallow stream in North Carolina.

Schultz (2001) suggested that Index of Water Shed Indicators is one such index created by the US - Environmental Protection Agency, to assess water shed vulnerability and condition in the United States. He also explained the credibility and applicability of subjective indices such as IWI, depends upon their ability to withstand the tests that challenge their internal consistency and interpretation. McDaniels (1996) and Kim et al (1998) gave the information about Multi Attribute Utility Theory (MAUT) which has been widely used. Also, it is consistent with the theory underlying other water-
quality indices such as the National Sanitation Foundation Water Quality Index.

The Clean Water Act of 1972 provided the initial legislative means for restoring the quality of the nation’s waters. Section 303 (d) of the federal Clean Water Act and the 1992 Total Maximum Daily Load (TMDL) regulations established the water quality standards and the maximum amount of a pollutant that a water body can receive and still meet water quality standards (Knopman and Smith 1993, Ahamed et al 2004). The author proposed water quality index as

\[
WQI = \log \left( \frac{(DO)^{1.5}}{(3.8)^{TP} \cdot (\text{Turb})^{0.15} \cdot (15)^{\text{FCol}/10000} + 0.14(\text{SC})^{0.5}} \right)
\]

Where,

DO  - Dissolved Oxygen (% oxygen saturation)
Turb - Turbidity (Nephelometric turbidity units [NTU])
TP  - Total phosphates (mg/L)
FCol - Fecal Coliform bacteria (Counts / 100 mL)
SC  - Specific conductivity in (MS / cm at 25°C)

The index was designed to range from 0 to 3. The maximum or ideal value of this index is 3. In very good water that have 100% dissolved oxygen, no TP, no fecal coliform, turbidity less than 1 NTU, and specific conductance less than 5 MS/cm, the value of this index will be 3. From 3 to 2, the water is acceptable, and less than 2 is marginal and remediation, likely in
the form of TMDLs, is needed. If one or two variables have deteriorated, the value of this index will be less than 2. If most of the variables have deteriorated, the index less than 1, which means that water quality is poor.

Oregon Water Quality Index (OWQI) (Cude 2001) is a single number that expresses water quality by integrating measurements of ten water quality variables (temp, DO, BOD, pH, NH$_3$, N, NO$_3$, total phosphorous, TDS and Fecal Coliform). It improves the comprehension of general water quality issues, communicates water quality states, and illustrates the need for and effectiveness of protective practices. The original OWQI used a weighted arithmetic mean function (McClelland, 1974).

\[
\text{WQI} = \frac{1}{n} \sum_{i=1}^{n} S_i W_i
\]

The NSF WQI (National Sanitation Foundation Water Quality Index) used a weighted geometric mean function

\[
\text{WQI} = \prod_{i=1}^{n} S_i^{W_i}
\]

where, WQI is Water Quality Index Result, $S_i$ is Sub index $i$, $W_i$ is weight given to sub index $i$.

The unweighted harmonic square mean formula, a method to aggregate the sub index results, has been suggested as an improvement on both the weighted arithmetic mean formula and the weighted geometric mean formula (Dojlido et al 1994).
\[ WQI = \sqrt[n]{\sum_{i=1}^{n} \frac{n}{1/\text{SI}_i^2}} \]

Where, WQI is Water Quality Index Result, n is the number of sub indices and \( \text{SI}_i \) is Sub index i.

This formula allows the most impaired variable to impart the greatest influence on the water quality index. It acknowledges that, different water quality variable will pose differing significance to overall water quality at different times and locations. The Oregon benchmarks report monitors progress towards Oregon’s strategic goals in areas ranging from the arts to public safety to the economy.

Groundwater hydro geological status has been inferred from an integration of the information from structural, lithological and vegetational information, Digital Elevation Model (DEM) along with available geologic, as well as topographic and hydrologic data for the study area Ken Graben-India. The use of spatial analysis, DEM for 3D visualization and terrain draping, thematic map overlays can be helpful in the interpretation of remotely sensed data (Srivastava 2002).

Landfill leachate application, the weighted Self-Organizing Map (SOM) assembles the microbial community data from monitoring wells into groupings believed to represent a gradient of site contamination that could aid in characterization and long-term monitoring decisions. Grouping based solely on microbial classifications are consistent with classifications of water quality from hydro chemical information. These microbial community profile data and improved decision-making strategy compliment traditional chemical ground water analyses for delineating spatial zones of ground water contamination. In community water systems, inadequate disinfection of
ground water and untreated ground water were the identified causes of 25 percent of the U.S. water borne disease out breaks reported between 1971 and 1992. Ground water, although filtered by natural processes, is often susceptible to microbial contamination and may need disinfection. A major ground water pathogen occurrence study, supported by the American Water Works Association (AWWA) Research Foundation and the U.S. Environmental Protection Agency (EPA), indicates that about 60% of vulnerable wells and about half of wells which were initially considered as not vulnerable, have been found to be positive for one or more indicators of fecal contamination in tests for total coliform bacteria, E.coliphage, and human viruses. Viruses were found to be about ten times more often than fecal bacteria, calling into question the adequacy of current coliform monitoring (Pearce et al 2011).

Mostly the pollutants are likely to enter ground waters by either the percolation through the unsaturated portion of the earth’s crust above the water table or discharge directly into ground water without passage through the upper soil layers. Both during percolation through the crust of the earth above the water table and within saturated ground-water zones, pollutants are subject to possible sorption, abiotic chemical alteration, and chemical alteration resulting from biological activity. Of the three possibilities, biological alteration may well be of greatest potential importance in determining the ultimate effect of a pollutant on ground-water quality (McNabb and Dunlap 1975).

Rhoton et al (2009) reported that the results indicate the effectiveness of ferrihydrite, as a means of reducing turbidity associated with suspended clays, was greatest at pH values below its zero point of charge. Ferrihydrite has the ability to sorb chemical contaminants and improve soil aggregation, it follows that this mineral might be as effective as a flocculent
to reduce turbidity levels and improve water quality in lakes and reservoirs. The objective of this research is to evaluate the effectiveness of a highly reactive naturally occurring ferrihydrite for flocculating suspended clays over a range of pH conditions.

The suspended solids absorb heat from sunlight to produce higher water temperature that further reduces the dissolved oxygen content. Such waters can become unproductive with respect to populations of aquatic organisms, and the overall water quality can be lowered for recreational uses and human consumption (Knight et al 2002). Some researchers have investigated the use of calcium sulfate (gypsum) in solid and solution forms to resolve turbidity problem through flocculation of sediment suspended in retention basins (Przepiora et al 1997). In addition to gypsum, synthetic, poorly crystalline iron oxides have proven to be effective for flocculating soil clays under laboratory conditions (Goldberg and Glaubig 1987, Goldberg et al 1990, Kretzschmar et al 1993). Ferrihydrite ($\text{Fe}_5\text{HO}_{8.4}\text{H}_2\text{O}$) is a poorly crystalline Fe oxide formed by the rapid oxidation of Fe (II) in ground water on exposure to atmospheric conditions in streams (Rhoton et al 2002) or during aeration at municipal water treatment facilities where the precipitated ferrihydryte is filtered out before the water is further treated for human consumption (Rhoton and Bigham 2005). Such precipitates are usually viewed as waste products, but recent research has shown that iron-rich water treatment residuals are effective scavengers of Arsenic and Lead (Beek et al 2006, 2006a) as well as Phosphorous (Rhoton and Bigham 2005) due to their purity and high sorptive capacities. Ferrihydrite from water treatment plant has also been used to increase the stability of surface soils for improved infiltration and reduced runoff. (Rhoton et al 2003).
An increase of atmospheric temperature leads to a systematic increase in total precipitable water. As a result, the residence time of water in the atmosphere increased, indicating a reduction of the global cycling rate (Bosilovich 2005).

Held and Soden (2006) found a robust decrease in extratropical sensible heat transport only in the equilibrium climate response, as estimated in slab ocean responses to the doubling of CO$_2$ and not in transient climate change scenarios.

The average recycling ratio at a spatial scale of 10$^5$ km$^2$ for all land areas of the globe is 4.5%; on a global basis, recycling shows a weak positive trend over the 25 years, driven largely by increases at high northern latitudes (Dirmeyer and Brubaker 2007).

Chang et al (2007) suggested that rainfall is an essential information for predicting water shed responses. It is also important to consider the properties of rainfall, particularly spatial rainfall variability, in the application of hydrologic and water quality models.

Huang et al (2008) assessed the method for water logging risk which is simple and applicable. The current research paper can provide guidance for the water logging risk analysis in a wider area of Huaihe River Basin.

Ketata et al (2011) assessed the water quality status for special use which is the main objective of any water monitoring studies. In 2007, February, 35 representative water samples were collected from boreholes (17) and wells (18). Samples were analysed for the major cation (Na, Ca, Mg, K) and anions (Cl, Sulphate, HCO$_3$, No$_3$) along with various physical and
chemical parameters like Temp, pH, TDS and EC. Based on the physico-chemical analyses, irrigation quality parameters like Sodium Absorption Ratio (SAR), Residual Sodium Carbonate (RSC), percentage of sodium (Na%), and Permeability Index (PI) were calculated. The quality water parameters value, were calculated by WHO guideline values.

Fresh water eco systems are the most vulnerable to warefare-related impacts, which is of concern given that they provide the society with many essential environmental resource and services (Francis 2011).

2.3 GAIA HYPOTHESIS

Gaia is the term used for Greek goddess-Mother Earth. This hypothesis suggests that life manipulates the environment for its betterment. The planet Earth works as a large organism capable of self-maintenance. The Gaia hypothesis is actually a series of containing several hypotheses. The first hypothesis suggests that life greatly affects planetary environment. The second idea asserts that life affects the environment for its own goodness. The third hypothesis of Gaia is about how life deliberately and consciously controls the global environment. It appears that the systems of positive and negative feedback that operate in the atmosphere and oceans are sufficient to explain the mechanisms by which life affects the environment.

The hypothesis, as a whole, has some merits as it relates to the present and the future status of life. The latter may depend on actions that are taken in the present. Today, the people living on Earth make conscious decision concerning the future of the planet.
2.4 BIODIVERSITY CONSERVATION

The need to save biodiversity is of utmost urgency. It is a common wish that the life-supporting system is retained (for long time). The balance of species and ecosystems is a key stone to a sustainable development - a development that meets the needs of the present generation without compromising on the ability of the future generations to meet their needs. Nevertheless, a new conservation framework has emerged in the recent days based on studying and saving biodiversity. It also illustrates how to exploit it sustainably as shown in Figure 2.1. The scope of biodiversity conservation is shown in Figure 2.2.

Figure 2.1 Elements of Biodiversity Conservation
2.5 EVOLUTION OF BIOSPHERE AND HUMAN ECOLOGY

Development of natural systems through steps and processes demands high energy flow, whereas, man harnesses the nature for his maximum yield. Therefore, it results into conflicts between man and nature. Man desires to obtain as much production as possible from the landscape by developing successional types of ecosystems. The safest landscape to live in is the one that contains a variety of crops, forests, lakes, and communities of different ecological ages. Therefore, a compromise is needed between the quantity of yield and quality of living space. The compromise needs compartmental strategies meaning that the environment should be further divided into compartments like natural, domesticated, and fabricated. Natural and domesticated environments constitute life-supporting systems whereas fabricated environments are parasitic. Further, natural environments cannot be
substituted whereas parasite environment can be tamed (Figure 2.3). Preservation of natural environments should be the goal of mankind.

Now the question arises, just how much natural environment should be preserved in a given political unit to support development of the society. The answer lies in comprehensive planning and management of evolutionary and ecological development. Planning should be an alternative to the uncontrolled development, which must ensure less consumption and much recycling.

Figure 2.3  Compartment Models for Environmental Use Planning (a) Partitioned According to Ecosystem Theory, (b) as Viewed by Environmental Architects and Designers
2.6 EARTH SUMMIT

United Nations Conference on Environment and Development, 1992, or the Earth Summit attracted 25,000 - 45,000 people at Rio de Janeiro (Brazil) in June 1992. In addition to government, delegations from the highest levels, upwards of ten thousand representatives from non-government organizations, indigenous associations, community activists, and environmentalists created a joint agenda for sustainable future that is called as Agenda 21.

To the academic community, it is especially noteworthy that three preparatory committee Working Groups were formed to provide with overall guidance on the matters that are distinctly relevant to the education and research agenda:

- Climate change, Conservation of biodiversity, and Management of biotechnology.
- Protection of the oceans and fresh water resources.

2.7 WORLD SUMMIT ON SUSTAINABLE DEVELOPMENT

WSSD at Johannesburg, during 2001, dealt about Freshwater in detail. Privatization of water and the relationship between the private and public sectors in water management were the key focuses of the WSSD discussions. Northern countries seem to be particularly pushing the agenda of privatization of water, identifying it as an economic good. The logistics of this proposal such as identifying the role of stack holders still remain hazy (Meenakshi 2010).
2.8 WATER CRISIS

The usage of water has increased six times in the past thirty years and the world is currently using 54% of annual fresh water. It is generally argued that the world is moving towards water wars. It is vague belief that the World War III may possibly arise owing to this issue of water crisis (Dharmendra, 2007).

2.9 UNITED NATIONS ENVIRONMENTAL PROGRAMME

The United Nations Environmental Programme (UNEP) was established by the United Nations in 1972 at Nairobi. It acts as a catalyst, advocate, educator, and facilitator to promote the wise use and sustainable development of the global environment. To accomplish this task, the UNEP works with a wide range of partners, including United Nation’s entities, international organisations, national governments, non-governmental organizations, the private sectors and the civil society. The objectives of UNEP are

- Assessing global, regional, and national environmental conditions and trends.
- Developing international and national environmental instruments.
- Strengthening institutions for a wise management of the environment.
- Facilitating transfer of knowledge and technology for sustainable development.
- Encouraging new partnerships and mind-sets within the civil society and the private sector.
2.10 INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

Mission of International Union for Conservation of Nature and Natural Resources (IUCN) is “to influence, encourage, and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable”. “IUCN builds bridges between governments and NGOs, science and society, local action and global policy. It is truly a world force for environmental governance”.

2.11 ENVIRONMENTAL PROTECTION AGENCY

Environmental Protection Agency (EPA) established by the US in response to the growing public demands for cleaner water, air, and land. EPA leads the nation’s environmental science, research, education, and assessment efforts with the following objectives (Rana, 2007).

- Develop and enforce regulations.
- Offer financial assistance.
- Conduct environmental research.
- Sponsor voluntary partnership and programmes.
- Further environmental education.

2.12 INDIAN ENVIRONMENTAL INSTITUTIONS

India’s active interest in environment was initiated in 1972 after the United Nations Conference on Human Environment. A National Committee on Environmental Planning and Coordination (NCEPC) was created to act as an apex advisory body of the Department of Science and Technology (DST).
The fourth Five Year Plan (1969-74) mentioned the need for comprehensive recognition of environmental issues in any developmental plan. The successor of NCEPC was the Department of Environment (DOEn) in 1980. The topics of wildlife and forests were added in the year 1985 and a new Ministry of Environment and Forest was created

Ministry of Environment and Forest looks after:

- Environmental laws and policies.
- Environmental monitoring and control.
- Survey and conservation of natural resources.
- Management of forests and conservation of wildlife.
- Education, awareness, and information on environmental issues.
- International cooperation.
- CPCB – Central Pollution Control Board.

Central Pollution Control Board (CPCB) was constituted under the provisions of the Water (Prevention and Control of Pollution) Act, 1974. The main functions of CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981 are:

- To promote cleanliness of streams and wells in different areas of the states through prevention, control and abatement of water pollution.
- To improve the quality of air and to prevent, control and abate air pollution in the country.
2.13 ENVIRONMENTAL POLICIES OF INDIA

The government’s environmental policy focuses on the following areas:

- Conservation of natural resources by direct action such as declaration of Reserved Forests, Biosphere, Wetlands, Mangroves, and protection of endangered species.
- Check further degradation of land and water through wasteland management and restoration of river water quality programmes.
- Monitoring development through Environmental Impact Assessment, studies of major project proposals.
- Penal measures for industries which violate Pollution Control Act.

2.14 ENVIRONMENTAL IMPACT ASSESSMENT

Analysis of any possible change in the environmental quality, adverse or beneficial, caused by a developmental project of government or private company is known as Environmental Impact Assessment (EIA). As a matter of Government policy, it is compulsory for any enterprise (govt/private) to include EIA in the planning stage of any developmental project and submit it to the Central Government for clearance. All major and minor irrigation projects and all highly polluting industries are subjected to EIA for their initiation.