Chapter 1
ENVIRONMENT AND HEALTH

1.1 Introduction

The term environment, which denotes surroundings, is a composite phrase for the conditions in which organisms live. It connotes the sum of all living and non-living things that surround an organism, or group of organisms. The meaning of the word ‘environment’ is elastic. Conventionally it refers to the various external factors that impinge on human health through exposures common to members of groups, communities or whole populations, and that are typically not under the control of individuals. In other words, environment is the sum of all social, economical, biological, physical or chemical factors which constitute the surroundings of man, who is both creator and moulder of his environment (Sharma, 2001). Within the context of environmental health, ‘environmental’ pertains to ‘all that which is external to the human host, including physical, biological, social and cultural aspects, any or all of which can influence the health status of populations’ (Last, 2001). People experience the environment in which they live as a combination of physical, chemical, biological, social, cultural, and economic conditions that differ according to the local geography, infrastructure, season, time of day, and activity undertaken (Smith et al., 1999).
Environment includes both biotic and abiotic factors that have influence on growth and development of organisms. The biophysical environment is the symbiosis between the physical environment and the biological life forms within the environment, and includes all variables that comprise the Earth's biosphere. It can be divided into two categories: the natural environment and the built-in environment, with some overlap between the two. Exposure to environmental conditions at the limit of organism's tolerance range represents environmental stress. It has always been changing, sometimes rapidly or drastically. These changes in environment may benefit or harm the man or other organisms living in it. Many species on earth could not cope up with changing environment, as a result of which they have vanished and many are on the brink of vanishing (Sharma, 2001).

In a very real sense, the world is in our hand and how we handle it will determine its composition, dynamics and our fate (Vitousek et al., 1997). Since the very beginning of human civilization, man started interfering with the environment. For several centuries he has exploited and reshaped the natural world in order to advance the material interests of industrializing and modernizing society leading to devastation of forest and pollution of environment. After the scientific and industrial revolution in the recent past, the magnitude of that environmental impact by human societies has increased exponentially. Man’s efforts to control nature have upset the equilibrium of the environment resulting in destructive effects.

One-third of the world’s productive land is significantly damaged by erosion, compaction, water logging and salination and chemical destruction of organic content. According to United Nations Environment Program (UNEP, 1999) about half of the damaged land is showing reduced
productivity. Increased nitrogen loading by humankind is affecting the acidity and nutrient balance of the world’s soils and waterways (Vitousek et al., 1997). Some 60% of the world’s vital ecosystems are degraded or being subjected to unsustainable pressures (World Resources Institute, 2005). The carbon dioxide concentration in the atmosphere has increased by nearly 30% since the beginning of the industrial revolution. More than half of all accessible surface fresh water is put to use by humanity and about one-quarter of the bird species on earth has been driven to extinction (World Resources Institute, 2005). The rate, scale, kind and combination of changes occurring now are more rapid than those at any other time in history. The harmful effects of depleted ecosystem services are borne disproportionately by the poor, including indigenous populations, who rely more directly on ecosystem services for basic food needs, shelter, livelihood and medicines, which are gradually being depleted by broader development processes (WHO, 2005a).

The past 40 years have seen rapid economic development. The accompanying industrialization and urbanization have brought about new environmental health hazards. The aggregate impact of the human population size and economic activity on several of the world’s biophysical systems has begun to exceed the regenerative and repair capacities of those systems. While we remain uncertain about the earth’s carrying capacity, we expect that the world population will approximate to nine billion by around 2050, and will probably stabilize at around 10–11 billion by the end of the twenty-first century (Cohen, 1995). The vulnerability of a population depends on factors such as population density, level of economic development, food availability, local environmental conditions, pre-existing health status, and the quality and availability of public health care.
The demographic growth and fast urbanization all over the world are bringing about profound social and environmental changes (Nagdeve, 2002; Wilcox and Gubler, 2005). During the last quarter of the twentieth century we began to see evidence of a general disturbance and weakening of the world’s life-supporting systems and processes (Watson et al., 1998). The combined pressure of energy-intensive and waste-generating economy, rapidly increasing population size and high consumption by humankind leads to unprecedented disruption of earth’s natural systems, at the global level (Vitousek et al., 1997; Nagdeve, 2002; Goffman, 2008). Air pollution, water pollution, deforestation, soil degradation, landslides and soil erosion are major consequences of environmental degradation and are causing tremendous loss in both life and property (Wang, 2004). Meanwhile, the ever-increasing demands of agricultural and livestock production are adding further stresses to the world’s arable lands and pastures. Direct impacts of agricultural development on the environment arise from farming activities, which contribute to soil erosion, land salination and loss of nutrients (Nagdeve, 2002), causing deterioration of soil health (Kapoor, 2001). Countries with large rural populations continue to suffer from traditional environmental risks such as indoor smoke from domestic cooking and heating with solid fuels, unsafe water supply, inadequate sanitation and poor hygiene.

The key to man’s health is his environment. The environment influences our health in many ways - through exposure to physical, chemical and biological risk factors, and related changes in our behaviour pattern in response to those factors. Environmental pollution not only leads to deteriorating environmental conditions but also adversely affects the health of people (Nagdeve, 2002). More recently, concerns about the health impacts of
changes in climate and ecosystems have been raised. In fact, much of man’s ill-health can be traced to adverse environmental factors such as water pollution, soil pollution, air pollution, poor housing conditions, presence of animal reservoirs and insect vectors.

The Millennium Ecosystem Assessment (MEA) estimates that approximately 60% of Earth’s major ecosystem services are being degraded or used unsustainably (WHO, 2005a; World Resources Institute, 2005). Global environmental changes can impact on agricultural production, exacerbating malnutrition and spur more extreme weather conditions, causing injuries and deaths (Willettts et al., 2009). Pressures on ecosystem services will continue to grow in the coming decades, with potentially serious implications for public health (Campbell-Lendrum et al., 2007). According to the World Development Report in 1997, 1.5 billion people live exposed to dangerous levels of air pollution, one billion live without clean water and two billion without sanitation.

1.1.1 Environment and Human Health

The relationship between human health and the environment is complex (Corvalan et al., 1999). The term ‘environmental health’ includes the effects on human health from the broad physical and social environment that includes housing, urban development, land-use and transportation, industry, and agriculture. Environmental health is concerned with environmental factors that influence or directly affect human health either positively or negatively (Corvalan et al., 1999). The World Health Organization (1994) has defined environmental health as ‘those aspects of human health, including quality of life, that are determined by chemical, physical, biological, social and psychosocial factors in the environment’.
This term is commonly used to describe the effects of contaminants in the environment on human health. These include physical, chemical and biological agents. Every person has a stake in environmental health. As environment deteriorates, so does the physical and mental health of the people who live in them. If parts of the environment, like air and water or soil become polluted, it can lead to health problems.

A clean and healthy environment is the most critical component essential for the well being of a society and the foundation for a sustainable and strong economy. Much of the ill-health in the world is due to poor environmental health (Stokols, 1992), i.e., unsafe water, polluted soil, unhygienic disposal of human excreta and refuse, poor housing, insects and rodents. Globally, about 43% of the total burden of disease due to environmental factors falls on children under five years of age, even though they make up only 12% of the population (Smith et al., 1999). Up to 40% of all deaths worldwide have been attributed to environmental exposure, such as use of tobacco, water pollution, and land degradation (Pimentel et al., 1998; Smith et al., 1999). The purpose of environmental health is to create and maintain ecological conditions that will promote health and thus prevent disease. The link between health of people, cleanliness and healthy habits in community has been well established from the inception of allopathic medicines itself (Smith, 2007).

In developing countries with large rural populations, people continue to suffer from traditional risks, including unsafe water, inadequate sanitation and hygiene, and indoor smoke from domestic cooking and heating. Chief environmental risk factors for asthma in children are ambient air pollution and housing conditions (Smith et al., 2004) such as chilling, crowding, and indoor air pollution (40-60%). Diarrhoeal diseases mostly (86%) affect young
children and are related to the environmental factors (Smith et al., 2004) such as poor sanitation, hygiene, and lack of access to clean water/food.

Improvement of environmental health is crucial for the prevention of disease and promotion of health of individuals and communities. The factors which are fundamental to individual and community health are water, air, ventilation, light, noise, radiation, meteorological environment and housing, disposal of wastes and excreta. Environmental health matters greatly to those living in poverty and directly affects the quality of life of those belonging to the poor income group (Miller, 2004; World Bank, 2006).

1.1.2 Environmental Health Risks

Environmental health risks are factors that relate to the natural world and the impact of human activity in its condition that increase the chance of disease or injury. From long-standing to emerging hazards, environmental factors are a root cause of an estimated one quarter of the global burden of disease – rising to more than one third in very poor regions (Smith et al., 1999; WHO, 2002; Pruss-Ustun and Corvalan, 2006). In general, environmental health risks are grouped into two broad categories - traditional hazards and modern hazards. Traditional hazards are closely linked to poverty. They refer to health risks that are a consequence of lack of access to clean water, inadequate sanitation, poor waste disposal, indoor air pollution and vector-borne diseases which are associated with lack of development. Modern hazards are related to rapid development that lacks health and environment safeguards and to unsustainable consumption of natural resources (Smith, 1990; Corvalan et al., 1999). These hazards include water pollution from populated areas, industry, and intensive agriculture; urban air pollution from automobiles, coal power stations, and industry; solid and
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hazardous waste accumulation; chemical and radiation hazards due to introduction of industrial and agricultural technologies; emerging and re-emerging infectious disease hazards; deforestation, land degradation, and other major ecological changes at local and regional level; climate change; stratospheric ozone depletion; and transboundary pollution (Corvalan et al., 1999). According to Pruss-Ustun and Corvalan (2006) the impact of traditional hazards is three times higher than modern hazards compared globally. The absolute impact of traditional risks is even more pronounced in the poorest areas (Ezzati et al., 2004). In developing countries, about 580,000 deaths per year are attributable to traditional risks. Modern risks are responsible for 405,000 deaths. Altogether, almost one million deaths in the region are attributable to environmental risks (WHO, 2005a). The burden of poor environmental health falls on the most vulnerable of the poor, mainly children under the age of five, women, and the disabled and elderly (Smith et al., 2004).

As we degrade our environmental benefits, we are lagging behind in providing the preventive public health strategies that we need to protect us against the resulting health risks. Environmental risk factors play a role in more than 80% of the major diseases and injuries around the world (Pruss-Ustun and Corvalan, 2006). Potentially avoidable environmental risks currently cause almost a quarter of the total burden of disease. The greatest impacts are on children and other vulnerable populations in developing countries (World Resources Institute, 2005). Thirteen million deaths annually are due to preventable environmental causes (WHO, 2005a). Preventing environmental risk could save as many as four million lives a year, in children alone, mostly in developing countries (WHO, 2003). Africa and Asia are most affected by environmental health-related diseases.
Early estimates of the global disease burden attributable to the environment were between 23% and 33% (WHO, 1997; Smith et al., 1999). A study of Organisation for Economic Co-operation and Development (OECD) countries, however, yielded significantly different results, concluding that only 2.1-5% of the overall disease burden was attributable to the environment (Melse and de Hollander, 2001). Pruss-Ustun and Corvalan (2006) estimated that 24 percent of the global disease burden and 23 percent of all deaths can be attributed to environmental factors. In developing countries the environmental burden of disease, with the total number of healthy life years lost per capita as a result of environmental burden is fifteen times higher than in developed countries (Pruss-Ustun and Corvalan, 2006). The three most dangerous risks that require priority attention are indoor smoke from solid fuels (contributing to 503,000 deaths), urban air pollution (355,000 deaths), and unsafe water, sanitation and hygiene (77,000 deaths) (WHO 1999 and 2005a). Globally, more than 1.5 million deaths annually from respiratory infections are attributable to environmental pollution (Pruss-Ustun and Corvalan, 2006).

Polluted indoor and outdoor air, contaminated water, lack of adequate sanitation, toxic hazards, disease vectors, ultraviolet radiation, and degraded ecosystems are all important environmental risk factors for children and in most cases for their mothers (WHO, 2002 and 2003). By far the greatest burden of disease falls on children under the age of five (Smith et al., 2004). Over five million children per year die from illnesses and other conditions caused by the unhealthy environments in which they live, learn and play. More than one-third of the diseases in children under the age of five years are caused by environmental exposure.

The top killers of children under five are acute respiratory infections (from indoor air pollution), diarrhoeal diseases (mostly from contaminated
water, sanitation and hygiene), and malaria (from inadequate environmental management and vector control) (Pruss-Ustun and Corvalan, 2006). Around two million children under five die every year from acute respiratory infections (Smith et al., 2004). Asthma rates among children in the United States more than doubled from 1980 through 1995, from 2.3 million to 5.5 million (Massey et al., 1989). A total of 1.3 million deaths of children each year are due to diarrhoea (The World Health Report, 2004). The mortality rate in children under five years of age from environmentally mediated disease conditions is 180 times higher among the poor compared with the rich (Pruss-Ustun and Corvalan, 2006).

In India, the prevalence of asthma varied between 1.8% to 17% in different parts of the country according to the nature of exposure, age group and gender (Viswanathan et al., 1966; Chowgule et al., 1998; Jindal et al., 2000; Gaur et al., 2003; Gaur et al., 2006; Jindal, 2012). The overall burden of asthma in India is more than 15 million patients (Viswanathan et al., 1966; Aggarwal et al., 2006). In a study from Mumbai, conducted as part of the European Community Respiratory Health Survey (Chowgule et al., 1998), asthma prevalence in adults aged 20-44 years was 3.5%. In a survey (Jindal et al., 2000; Aggarwal et al., 2006) of more than 2000 individuals, asthma was diagnosed in 2.28%, 1.69%, 2.05% and 3.47% respondents respectively at Chandigarh, Delhi, Kanpur and Bangalore, with overall prevalence of 2.38%. In another study among 169575 people from different parts of India, Jindal (2012) reported that one or more respiratory symptoms were present in 8.5% of individuals. The overall prevalence of asthma and chronic bronchitis was 2.05% (adults aged ≥15 years) and 3.49% (adults aged ≥35 years) respectively.
Humans are stressed and disease prevalence is worsened, by widespread malnutrition and the unprecedented increase in air, water and soil pollution. The impact of air pollution will get worse as the number of vehicles on the road is rising at three times the rate of world’s population. Smoke from indoor cooking fire kills 4 million children per year and lack of sanitary conditions contributes to another 4 million deaths, mostly among infants in developing countries (Sharma, 2001). Indoor smoke is a particular problem in highland areas. A number of studies in hilly areas have reported association between asthma and exposure to indoor air pollution and cold in adults, especially women and acute lower respiratory infection which is the chief cause of death in children, presumably because of the high daily concentrations of pollutants found in indoor environment and the large amount of time young children spend with their mothers doing household cooking (Smith et al., 2004).

Contaminated drinking water contributes to disease in developing and developed countries worldwide (Campbell-Lendrum et al., 2007). The overall disease burden related to unsafe water, sanitation and hygiene has been examined at a global level (Murray and Lopez, 1996; WHO, 2002; Cairncross and Valdmanis, 2006; Fewtrell et al., 2007; WHO, 2007; Pruss-Ustun et al., 2008). According to these studies almost one tenth of the global burden of disease can be attributed to water, sanitation and hygiene. Diarrhoeal disease alone amounts to an estimated 4.1% of the total daily global burden of disease and is responsible for the deaths of 1.8 million people every year (Campbell-Lendrum et al., 2007). It was estimated that 88% of that burden is attributable to unsafe water supply, sanitation and hygiene and is mostly concentrated on children in developing countries. In the last 50 years, at least 50 million people have died prematurely due to
diarrhoea and malnutrition (The World Health Report, 2004). To prevent disease it is essential that their underlying causes (health risks) are quantitatively attributed (Pruss-Ustun et al., 2003).

1.1.3 The Indian Scenario

India is one of the most degraded environment countries in the world. According to a World Bank sponsored study, estimated environmental damage in the year 1992 amounted to about Rs.34,000 crores, which is 4.5% of GDP. Water degradation leads to health costs amounting to nearly 60 percent of the total environmental cost. Soil erosion affects 83 to 163 million hectares of land every year. The high death rate, infant mortality rate, sickness rate and poor standards of health in India are due to defective environmental health. Environmental pollution is one of the serious problems faced by the people in India (Nagdeve, 2002). Rapid population growth, industrialization and urbanization in the country are adversely affecting the environment (Nagdeve, 2002). It is evident that most of the land in the country is degrading, thus affecting the productive resource base of the economy. Out of the total geographical area of 328.7 million hectares, 175 million hectares are considered to be land-degraded area. Urban air pollution costs India US $1.3 billion a year. India loses about US $80 billion every year on account of sickness and death from pollution and economic costs attributed to resource degradation, says the World Bank’s Annual Environmental Review (Nagdeve, 2002).

Environmental degradation in the region continues to worsen with increasing industrial pollution in urban areas and degeneration from the unsustainable use of land, forest and water resources in rural and coastal areas. The living conditions prevalent in a human settlement, whether rural or
urban, reflect the health status of its populace. Nearly 80% of India’s population lives in villages. Majority of rural people defecate in the open fields and dry river beds. Due to the lack of provision for safe disposal, refuse and human wastes are thrown into lanes or dumped in backyards. These wastes are later washed by rain to the sources of water, posing a danger to the fitness and well-being of the community, in the form of diseases (Kapoor, 2001). In India, at least one million children died every year since independence because of lack of clean drinking water (Sharma, 2001). According to a study, 84,000 deaths were directly attributable to outdoor air pollution in Indian cities, whereas indoor air pollution accounted for 496,000 deaths in villages and 93,000 deaths in cities (WHO, 1997).

1.1.4 Environment Health Indicators

An environmental health indicator can be defined as an expression of the link between environment and health, targeted at an issue of specific policy or management concern and presented in a form which facilitates interpretation for effective decision-making (Corvalan et al., 1999). Indicators are divided into three broad areas of environmental health: water, air, and chemical/physical agents. An ideal indicator is one which can be measured, monitored over time, has a linkage between environment and health, is tied to public health objectives, and relates to existing standards, among other attributes. Environmental health indicators should be valid, measurable, accurate and sensitive to changes in the environment that affect human health, and data to compute the indicator should be available.

Major indicators of environmental health are outdoor and indoor air quality, water quality, toxics and wastes, healthy homes, healthy communities and good infrastructure. Up to 40% of all deaths worldwide have been
attributed to environmental exposure, such as use of tobacco, water pollution, and land degradation (Pimetel *et al.*, 1998; Smith *et al.*, 1999). Estimates suggest that up to one-third of the global burden of diseases can be attributed to negative environmental indicators, such as polluted water and air.

### 1.1.4.1 Air

The air we breathe is heavy with toxins. Air pollution is responsible for half the cases of chronic coughing in urban children and facilitates the spread of respiratory infection. In the poor and developing countries, air pollution in the form of soot and smoke has increased. More than one billion urban residents worldwide breathe air that does not meet WHO air quality standards (Sharma, 2001). In developing countries, indoor air pollution is largely attributed to smoking and the use of biomass for cooking (Rehfuess *et al.*, 2006).

This indicator provides a measure of the state of the environment in terms of air quality and is an indirect measure of population exposure to air pollution. The air we breathe contains varying levels of pollutants such as particulate matter, sulfur dioxide, oxides of nitrogen, ozone, carbon monoxide and volatile organic compounds derived from motor vehicles, industry, housing and commercial sources. Despite efforts to reduce pollution levels, they continue to pose risks to human health.

Epidemiological evidence shows that various health effects, including illness and death from respiratory and cardiovascular diseases, are associated with air pollutants. Exposure to air pollutants may lead to short-term effects such as reduced visibility, headaches, allergic reactions, irritation to the eyes, nose and throat, and longer term effects such as breathing difficulties, asthma and various chronic respiratory illnesses such as lung cancer and heart disease. Indoor air pollution is responsible for over 1.5 million deaths from
respiratory infection per year and for 2.7 percent of the global burden of disease (WHO, 2006). In infants and young children, the effects can be far more (Smith et al., 2004). Children with asthma are believed to be particularly sensitive to air pollution. Air pollution may also act synergistically with other environmental factors to worsen asthma.

1.1.4.2 Water

Water is the most basic need of human kind. Water is available in nature in the form of ground and surface water. The utilization of water for various activities depends on its physical, chemical, and biological characteristics. Water is a vital environmental factor to all forms of life. There can be no state of positive health and well-being without safe water. Since drinking is considered to be the most essential use of water for life, it must be free of health hazards such as pathogens, toxins and carcinogens. Much of the ill-health which affects humanity can be traced to lack of safe and wholesome water supply. Contaminated drinking water is a major cause of illness and mortality resulting from exposures to infectious substances or chemical contaminants (Nagdeve, 2002). The potential of drinking water to transport microbial pathogens to great numbers of people, causing subsequent illness, is well documented in all countries.

With 1.1 billion people lacking access to safe drinking water, and 2.6 billion without adequate sanitation, the magnitude of the water and sanitation problem remains significant (WHO, 2005b; UNICEF, 2006). Each year contaminated water and poor sanitation contribute toward the 5.4 billion cases of diarrhoea worldwide per year and the 1.6 million deaths, mostly among children under the age of five (Hutton and Haller, 2004). Elevated rate of diarrhoeal morbidity is a good indicator of environmental health because high rates occur in
areas of poor sanitation and crowding (Davis et al., 2002). In India, main sources of water pollution are domestic sewage, industrial effluents and run-off from activities such as agriculture (Nagdeve, 2002).

1.1.4.3 Indoor Environment

The poor living in slums are exposed to multiple environment health risks such as overcrowding, poor ventilation, dirty floors and inefficient cooking practices (Parkinson, 2007). Most of the rural houses in villages are built of mud-concrete or combinations of wood, bamboo, asbestos and thatched roofs which are insanitary, poorly designed, made of non-durable material and often in dilapidated condition. Cattle sheds are quite near to the living rooms and the surroundings are often polluted, owing to the lack of adequate drainage and sanitation. These result in dark, damp and dingy dwelling places for flies, mosquitoes, rodents and pathogens everywhere. The problem is even graver in the rainy seasons because the kacha straw-roofs allow leakage of rain-water due to which the mud-floor gets dislodged making water to stagnate and serve as a breeding place for mosquitoes and flies that contaminate the food and water used for human consumption (Kapoor, 2001).

It has been suggested that the increase in morbidity and mortality for asthma and allergies may also be due to an increase in exposure to allergens in the indoor environment. Indoor allergen exposure is recognized as the most important risk factor for asthma in children. Asthma development, prevalence and exacerbation can be triggered by a variety of indoor environmental exposures such as dampness, house dust mites, pets, insects, plants, moulds and chemical agents. Indoor smoke from solid fuels and environmental tobacco smoke are also significant triggers for asthma symptoms and attacks.
Fungi are known to cause a spectrum of clinical diseases (Tobin et al., 1987; Burge, 1990; Jarvis, 1990; Flannigan et al., 1991). Potentially pathogenic fungi are not uncommon in the indoor environment (Johanning et al., 1996). Many epidemiological studies from several countries have consistently detected an association between respiratory symptoms and reported home dampness and mould growth (Strachan and Elton, 1986; Waegemaekers et al., 1989; Brunekreef et al., 1989; Strachan et al., 1990; Platt et al., 1990; Hyndman, 1990; Dales et al., 1991; Brunekreef, 1992; Verhoeff et al., 1995; Pruss-Ustun and Corvalan, 2006).

1.1.5 Mountain Ecosystem

The definition of a mountain region can be based on numerous criteria including height, slope, climate, and vegetation. A simple definition is “areas above 3000m”- a category that encompasses about 5 percent of the world’s terrestrial surface and an estimated 120 million people. A total of about half a billion people live in uplands and mountains. Mountain ecosystems encompass a range of shapes, climates and compositions of vegetation and animal species depending on elevation and latitude.

Half of the world’s population depends on mountain water. All the major rivers of the world originate in mountains that receive high levels of precipitation as rain. Mountain forests help filter the water and protect its quality. On average, mountains are semiarid and arid environment providing 70-95 percent of downstream freshwater. High elevation water flows also power many of the world’s hydroelectric power projects.

1.1.6 The Western Ghats

The Western Ghats, also known as the Sahyadri Mountains, is a mountain range along the western side of India. It runs from 22° N in
Mumbai south to 80° N in the southern tip along the western edge of the Deccan Plateau, and separates the plateau from a narrow coastal plain along the Arabian Sea. The range starts near the border of Gujarat and Maharashtra, south of the River Tapti, approximately 1600 km through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala, ending at Kanyakumari, at the southern tip of India. These hills cover 60,000 km² and form the catchment area for a complex of river systems that drain almost 40% of India. The average elevation is around 1,200 meters.

Basalt is the predominant rock found in the hills, reaching a depth of 3 km (2 miles). Other rock types found are charnockites, granite gneiss, khondalites, leptynites, metamorphic gneisses with detached occurrences of crystalline limestone, iron ore, dolerites, anorthosites, residual laterite and bauxite ores.

Climate in the Western Ghats varies with altitudinal gradation and distance from the equator. The climate is humid and tropical in the lower reaches tempered by the proximity to the sea. Elevations of 1,500 m (4,921 ft) and above in the north and 2,000 m (6,562 ft) and above in the south have a more temperate climate. Average annual temperature here is around 15° C. In some parts frost is common, and temperatures touch the freezing point during the winter months. Mean temperature ranges from 20° C in the south to 24° C in the north. It has also been observed that the coldest periods coincide with the wettest.

During the monsoon season rainfall in this region averages 3,000 - 4,000 mm with localised extremes touching 9,000 mm (350 in). The eastern region of the Western Ghats which lie in the rain shadow, receive far less rainfall averaging about 1,000 mm (40 in) bringing the average rainfall figure to 2,500 mm (100 in). Areas to the north in Maharashtra receive the heaviest
rainfall, but are followed by long dry spells, while regions closer to the equator receive less annual rainfall, with rain spells lasting almost the entire year. The majority of streams draining the Western Ghats join the Rivers Tambaraparani, Godavari, Krishna, and Kaveri and drain out into the Bay of Bengal. The west-flowing rivers that drain into the Arabian Sea are Mandovi and Zuari.

There is a great variety of vegetation all along the Ghats with scrub jungles in the low-lying rain shadow areas and the plains, deciduous and tropical rainforests up to about 1,500 m and a unique mosaic of mountain forests and rolling grasslands (shola) above 1,500 m. The Western Ghats are an area of exceptional biological diversity and conservation interest, and are one of the major tropical evergreen forest regions in India. The area is one of the world’s ten "Hottest Biodiversity Hotspots" and has over 5,000 species of flowering plants, 139 of mammals, 508 of birds, and 179 of amphibians. At least 325 globally threatened species are found in the Western Ghats (Myers et al., 2000). The Western Ghats in Kerala is home to many tea and coffee plantations.

The whole area of Western Ghats is 159,000 sq.km, of which forest cover is about one third. The forest in the Western Ghats has been severely fragmented due to human interference. Complex and species-rich habitats like the tropical rainforest are much more adversely affected than other habitats. During the past 40 to 50 years the plant and animal life has suffered due to development and urbanization, which has led to the extinction of many species and more are in danger of becoming extinct.

1.2 Significance of the Study

The grandeur of mountain ecosystems belies their delicacy. Thin soils and slope instability in turn raise the vulnerability of mountains to human
disturbances and require lengthy recovery time. Persistent abuse usually leads to irreversible degradation. Unfortunately the environment has been persistently abused in many parts of high-land areas for thirty years or more. From the Andes to the Himalayas, and from Southeast Asia to East and Central Africa, there is serious ecological deterioration. Mountain regions also have a long history of political neglect and economic exploitation.

Nedumkandam - a high range panchayat from Western Ghats in Idukki district of Kerala is undergoing aggressive developmental activities. The inevitable result of development is environmental degradation. This panchayat is facing serious environmental health issues due to unscientific developmental as well as agricultural activities. Substantial amounts of fertilizers and pesticides are applied in the agriculture sector especially among cardamom plantations. The quality of water and soil is deteriorating due to unscientific agricultural practices and waste disposal. Many people are affected by water borne diseases such as dysentery, diarrhoea, gastroenteritis etc. every year. The number of patients suffering from asthma and cancer show a steady increase. Moreover the high range area is under threat of climate change impacts. The amount of annual rainfall is decreasing and the air temperature is showing an increasing trend. Nature can be very forgiving - though not indefinitely. Trends in population growth, inadequate wastewater treatment, global warming and increasingly extensive mountain forest destruction, high soil erosion, declining organic matter and pollution all suggest that this mountain ecosystem is constantly under serious threat.

As per Central Ground Water Board, the ground water resource of Nedumkandam Panchayat is in semi-critical category. There is significant decline in pre monsoon and post monsoon ground water table. Environment quality monitoring and assessment at regional and local levels is imperative.
for determining the status and trends of environmental health which will help to devise preventive measures against health hazards. Information regarding the impact on health, attributable to environmental pollution, at local and national levels is urgently needed so that the potential effects of environmental degradation can be assessed and irreversible health and environmental damage can be prevented. Very few studies have been conducted regarding environmental quality and its influence on human health in high range areas. The present study is a preliminary attempt to provide baseline information about the general environmental quality of the Nedumkandam Panchayat and its influence on human health.

1.3 Objectives:

The aim of the work was to assess the environmental health of Nedumkandam panchayat by analyzing the different parameters that controls and contributes the wellbeing of the people by controlling the environment itself. Major objectives of this research are as follows:

1) To monitor the environment quality of Nedumkandam panchayat with special reference to air and water.

2) To study the relationship between prevalence of asthma and the quality of indoor and outdoor air

3) To study the relationship between prevalence of waterborne diseases and quality of water in the study area

4) To assess the relationship between land use/land cover changes and environmental health of Nedumkandam panchayat
1.4 Research Design, Study Area and Methodology

1.4.1 Research Design

- Survey of the entire study area on the prevalence of respiratory allergy, using a standardized questionnaire.
- Dust sampling from the indoor environment and assessment of the occurrence of fungal spores.
- Monitoring of air quality of the study area, using high volume air sampler.
- Survey on the prevalence of water borne diseases.
- Assessment of the water quality in the study area, including ground water and surface water.
- Assessment of the land use/land cover changes in Nedumkandam panchayat.
- Correlating the results with special reference to environmental degradation and its impact on human health.

1.4.2 Study Area

Nedumkandam, known as the capital of High-Ranges, is the major town of Udumbanchola taluk in Idukki district of Kerala state in India with a history of less than four decades. It is located in between the Periyar wild life reserve in Thekkady and the hill station of Munnar in the upland region of Western Ghats. The study area is enclosed between Latitudes 9°48’00” to 9°52’00” North and Longitude 77°06’00 to 77°15’00” East, covering an area of 71.95 Km² (Figure 1.1). It is bounded by Udumbanchola panchayat at north,
Pampadumpara panchayat at south, Tamil Nadu state at east, Irattayar and Vathikudi panchayats at west. Nearest tourist spots are Kailasapara, Kallumekallu, Mankuthimedu, Ramakalmedu and Neyyandimala.

The area experiences good to high rainfall. The annual rainfall varies from 2500 to 4250 mm during the southwest monsoon (June - August) and northeast monsoon (October - December) seasons. The major river flowing through the area is Kallar, which joins the Periyar River. The elevation ranges between 100 m and 1,100 m above MSL from west to east. Temperature in the area varies from 16° to 32° Celsius.

This is a land of migrant farmers from the low-lying regions of Kerala, especially Kottayam, Pala and Muvattupuzha, who came in search of better pastures (cultivable lands) and ultimately ended up in the reserve forests. General land use/land cover pattern of the area is built up land, commercial land, natural vegetation and plantation crops. Major agricultural crops include pepper, cardamom, coffee, coconut, areca nut, cocoa, ginger, rubber and plantain. Besides these, a wide variety of other cash crops are also being cultivated. Cardamom farms are larger and about half of the owners are Tamilians whose parents ascended the ghats from Cumbam and Bodinaikanur areas of Tamil Nadu to cultivate the forest soils of the Cardamom Hill Reserve areas.
Environmental Health Perspectives of a Panchayat in Idukki District of Western Ghats

Figure 1.1: Study Area Location Map of Nedumkandam Panchayat
The number of households in Nedumkandam panchayat is 9,301 and the total population is 39,165. Among these, 19,531 are male and 19,634 are female (Census of India, 2001). Most of the people are small-scale farmers and agricultural labourers.

**Major Environmental Problems**

This panchayat is facing serious environmental health issues due to aggressive, unscientific developmental as well as agricultural activities. Huge amount of fertilizers and pesticides are applied in the agriculture sector especially among cardamom plantations. The quality of water and soil is deteriorating. Deterioration in the environmental quality is reflected in the increasing number of people affected with water borne diseases such as dysentery, diarrhea, gastroenteritis and air borne problems such as asthma. Number of people suffering from cancer is also on the rise.

**1.5 Organization of Thesis**

The structure of this thesis broadly corresponds to the chronological order that was adopted throughout the research, which also relates to the objectives listed previously.

- Chapter 1 deals with general introduction in its wider context, scope of the study, objectives and description of study area.
- Chapter 2 covers general air quality, quality of housing and indoor allergens prevalent in the study area. Particular attention is focused on the survey data sets and its statistical analysis.
- Chapter 3 presents the assessment of water quality and spatial modeling using Geographic Information System (GIS).
Chapter 1

- Chapter 4 explains the land use/land cover dynamics of the study area and its significance in environmental health of the area.
- Chapter 5 summarizes the major conclusions and recommendations culminating this study.

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