Chapter Two

LITERATURE REVIEW

Chapter 2.0 Literature Review

2.1 Historical Development of the Basic Concepts of Sustainable Development

Reed (1996) has commented on the fact that the United Nations Conference on the Human Environment held in Stockholm in 1972 had reflected the mounting public concern in the developed societies on the negative impacts of industrialization, with the cumulative impacts of stationary and mobile pollution. Books such as the *Silent Spring* (1962), *The Population Bomb* (1970), and *The Limits to Growth* (1972) expounded on the neo-Malthusian theory by expression doomsday scenarios of uninhabitable planet earth caused by shrinking resource base, spreading pollution and ever expanding population. Therefore, the ability of the planet earth to continue the support of human existence with its deteriorating resources is getting wide spread attention.

On the other hand, the developing countries identified that poverty, not industrialization, was the overriding cause of environmental degradation. The Stockholm Declaration recognized the developing countries' perspective that pollution caused by the industrialization of the North imposed constraints on the South's development and industrialization option, which is viewed as the principal answer to environmental problems.

In the subsequent two decades in the 70s and the 80s, the growing public pressure and the conflicting North-South development perspectives drove the evolution of the conceptual foundation of sustainable development. Public concerns were spurred by the increasing environmental crises in both localized disasters, such as the mass chemical contamination in Bhopal (1984) and the Chernobyl nuclear accident in Ukraine (1986),

and the cross regional global environmental problems such as acid rain, destruction of tropical rain forest, stratospheric ozone depletion and global warming.

In 1980, the World Conservation Strategy (WCS, 1983) promoted by the International Union for the Conservation of Nature and Nature Resources (IUCN) called for the sustainable use of species and ecosystems. The strategy promotes carefully planned natural resources development for the welfare of human being with respect to the carrying capacities of the ecosystems. The approaches of WCS were based on morally persuasive statements and did not receive sufficient recognition internationally due to the divided political realities of the North-South.

However, the concept of sustainable development has since been used in international circles and it strengthens the theoretical foundation for the next articulation of sustainable development. The World Commission on Environment and Development (WCED, 1987), also known as Brundtland Commission pushed the concept of sustainable development to the center stage of international affair. In its 1987 report, *Our Common Future,* it concluded that the rapid deterioration of the global environment was threatening life on the planet earth and decisive political actions are required to ensure human survival.

WCED recognizes the relation between the problems of environmental degradation and poverty. The report also explained how some uncontrolled developments would erode the environmental resources upon which they are based, and how the degraded environment would ultimately undermine the economic development. Thus, it called for 'changing the quality of development'. Political and economical transformations are

required in order to support sustainable development throughout the world. Sustainable development was then defined as:

> "Development that meets the needs of the present without compromising the ability of future generations to meet their needs."

Within this statement, there are three key concepts that require more precise definition. These are development, needs and future generations.

Development should not be confused with growth that predominantly conveys the idea of physical or quantitative expansion of the economic system. Development is a qualitative concept of progress and improvement that incorporates cultural, social as well as economic dimensions. In the concepts of sustainable development, the utilization of natural resources should consider its carrying capacity including the assimilative, regenerative, recuperative ability of the system to maintain productivity.

Intrageneration equity is an important concept incorporated into the needs introduced in the definition of sustainable development. The Brundtland Commission defines sustainability as 'meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life'. However, in the developed countries, growing affluence has made luxuries into needs; yet people in the under-developed countries are unable to satisfy basic necessities, let alone meet their modest aspirations. In global perspective, the environmental cost is too high to continue supporting the life style of the rich as well as meeting the needs and increasing demand of the poor. The global resources may not be able to satisfy the greed of human being and also the needs of exponentially increasing population. Therefore, changing of life style and intrageneration equity is a moral issue in the concepts of meeting needs. Redistribution

of resources in various forms including technology transfer, financial aid, and compensation to prevent environmental degradation, is required to achieve greater social equality.

The third major concept in the definition of sustainable development is the principle of intergeneration equity. There is a moral obligation to hand on a better environment to the future generation in order for them to secure their own needs. In the process of development to meet the needs of this generation, it is not only necessary to avoid irreversible damage to the global ecosystem, such as destruction of genetic resources, but also to rectify the heavily degraded environment and to improve socially deprived communities.

In response to the Brundtland report, the United Nations Conference on Environment and Development, generally known as the Earth Summit, was held in Rio de Janeiro in 1992. There were five documents that were signed in the Earth Summit to implement sustainable development. These were the treaty on climate change, the treaty on biodiversity, the convention on forest principles, the Rio Declaration, and Agenda 21.

As one of the most important documents signed in the Earth Summit, the Rio Declaration on Environment and Development is a non-binding set of 27 principles on sustainable development. It is a guide for the world's nations to implement development plan in the future. Two of the significant principles are:

1) The polluter pay principle

   The polluter of the environment should internalize the cost of pollution.

2) The precautionary principle

Scientific uncertainty should not be the reason for postponing urgent measures to prevent environmental degradation or to ignore the possible negative effects in the process of exploiting natural resources.

Agenda 21 is one of the most significant documents of the Earth Summit agreements. It is a blueprint for international action in the 21st century. There are 40 chapters that focus on adopting new environmental programs and call for reforms of economic, social and international institutions to achieve sustainable development.

2.2 Sustainable Mountain Development

As the research area of this dissertation falls within a mountain range, the following section will examine the concepts of sustainable development on a mountain environment. Among the 40 chapters in Agenda 21, Chapter 13 is titled 'Managing Fragile Ecosystems: Sustainable Mountain development'. The concept of sustainable mountain development is first used in this chapter and was accorded comparable priority in the global debate on the environment and development with issues such as global climate change, desertification and deforestation (Price & Kim, 1999).

2.2.1 Mountain Ecosystem

The definition of mountain tends to vary with local topography. There is no precise definition based on altitude, but is usually used for any area with abrupt rises in altitude from the surrounding area and has environment and ecosystem that are different from those in the low land. An increase of altitude will induce temperature decline. The rate is about 6° C per 1,000-m rise in altitude. However, the actual temperature decline is

also influenced by seasons, air mass type, and with variation in topography and vegetation cover (Tomlinson & Whalley, 1999). Due to this vertical dimension, mountains also create gradients of precipitation and insolation.

Thus, a particular mountain slope may include several climatic systems, such as tropical, subtropical, temperate, alpine and montane. Each of these systems represents an ecological system of large habitat diversity. Thus, mountain and hillside areas hold very rich species and genetics diversity.

In Peninsular Malaysia, montane rain forest is an important system as the altitude increases. Lower Montane Rain Forest occurs from around 750 to 1,200-m up to around 1,500-m, that sometimes even exist at 2,350-m elevation. Due to a few characteristic dipterocarp trees found in the lower part of this montane forest formation, it is also called the Upper Dipterocarp Forest. The upper part of this forest is rich in oak and laurel species. Thus, it is sometimes known as the Oak-Laurel Forest.

As the elevation increases, the Upper Montane Forest formation exists at 1,200 m to 1,500 m up to 2,100 m to 2,800 m elevations. This elevation is covered with trees and shrubs of the Rhododendron family and is called the Montane Ericaceous Forest. The forest is characterized by low canopy, reaching only to 18 m high, but can be merely 1.5 m high. Most trees are of very small sizes, and often with crooked, twisted stems and branches and resemble dwarfed, stunted trees. Due to this, it is also called the Elfin Forest. Moreover, due to daily cloud cover, the humidity is high with lower temperature. Mosses and live worts are very common in this forest. Thus, it is also called the Mossy Forest. As water condensation on the plant is high, there is plenty of

water brought into the system. The other significant feature is the accumulation of peat. This is due to the low rate of decomposition of organic matter at lower temperature.

The vegetation of CH shows the typical altitudinal zonation of vegetation belts of Malaysian's mountain. The vegetation changes from the Upper Dipterocarp Forest to Upper Montane Forest as the altitude ascending from Ringlet to the summit of higher mountain in CH.

2.2.2 Development and Problems in Mountain Areas

About 10 percent of the world's population depend directly on mountain resources. However, there is a much larger percentage of the world's population that indirectly draws on mountain resources, including its fresh water supply. Mountain attracts attentions of development because it is an important source of water, energy and biological resources. As the result of over exploitation of these resources, global mountain environment experiences tremendous degradation.

On the other hand, accessibility in mountain areas can be low due to topographic barriers. Mountain communities are remote from education, health and public utilities. Generally, mountains have become marginal areas in today's global economy. There is widespread poverty among mountain inhabitants and loss of indigenous knowledge. As stated in Chapter 13 of Agenda 21,

> "Mountains are highly vulnerable to human and natural ecological imbalance. Mountains are the areas most sensitive to all climate changes in the atmosphere".

As the height increases, the difference in potential energy between lowland and mountain increases. Significant difference in potential energy is very obvious between peak and valley, especially in high gradients slope. Furthermore, the types of ecosystem, soil, vegetation, and climate change abruptly as the altitude increases. These factors contribute to the sensitivity and potential hazards of the mountains. Mountain areas in humid tropical regions are susceptible to accelerated soil erosion, torrential runoff, landslides, mudflows and rockfalls. These mountain hazards are imminent threats to human use of mountain environment.

As it is located among the highest mountain in the Peninsular Malaysia, CH inherits the natural characteristics and hazardous potential of mountains. In CH, human intervention is the most intense in all mountain areas in Malaysia. Therefore, the consequences of the human intervention on the natural environment and its ability to absorb the stress are critical to determine the stability of the ecosystem as well as the sustainability of the human development activities in CH.

2.2.3 Sustainable Mountain Development and Its Indicators

A primary need in assessing sustainability is to be able to integrate the single or multiple purpose approach to a holistic and multi-disciplinary framework with regional perspective in its view. They must be seen as planning and management activities that are intimately intertwined with broader societal demands and issues (Loucks & Gladwell, 1999). Thus, an integrated approach is needed in conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources. Moreover, the interrelationship among the a-biotic and biotic components in the mountain region is very strong and sensitive. Hence, the proper management of mountain natural resources and socioeconomic development of the people deserves immediate action.

The sustainable development of mountain ecosystems will depend on the development of a self-sustaining diversified mountain economy. It is closely associated with human welfare and ecological conditions that allow the people to love their homelands and obtain adequate nutrition, health care, education, income and other basic human needs.

Sustainable development is a continuous process with no definite objectives and is likely to change over time. Thus, to assist development planning, monitoring, and evaluate success, indicators are needed. Based on the Chapter 13 of Agenda 21, United Nation Food and Agriculture Organization (FAO) have developed a set of indicator using "pressure-state-response" (PSR) framework (UN, 1999). This framework, which is developed by OECD (1993), is commonly used for establishing environmental indicators. PSR is a feed back loop in which "pressures" (or driving forces) reflect the human and principally economic activity that affects the environment. "State" variables describe the condition of the environment, and the "response" indicators describe the societal and policy responses to environmental change (Crabtree & Bayfield, 1998).

The PSR framework (see **Fig. 2.2.1**) is based on the concept of causality: human activities exert pressures on the environment and change its quality and the quantity of natural resources, that is the state of the environment. Society responds to these changes through environmental, general economic and sectoral policies. This formed a feedback loop to pressures through human activities. The entire framework forms parts of an environmental policy cycle that includes problem perception, policy formulation, monitoring and policy evaluation. However, the weakness of PSR, which highlights these links, tends to suggest a linear relationship in the human activities and environmental interaction. The complexity of interaction of environment-economy and the working of ecosystem should be noted.

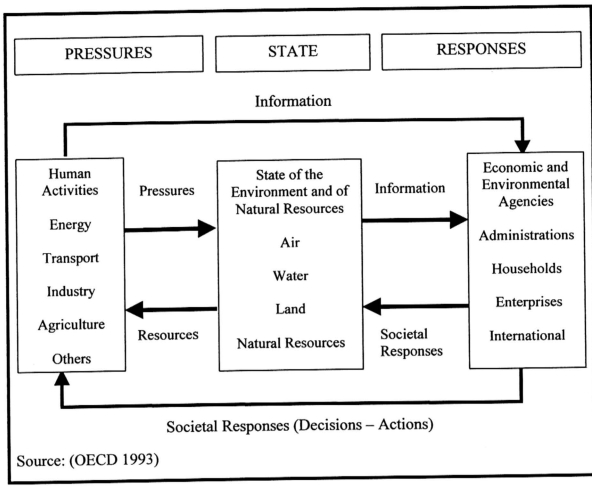

Fig. 2.2.1: Pressure-State-Response Framework

The FAO's indicators include a "pressure" indicator and two "state" indicators. No response indicator is recommended. The proposed "pressure" indicator is the population changes in mountain areas. The purpose of this indicator is to show the extent to which overall population density, migration patterns, and other demographic measures affect sustainable mountain development, including resource availability and management. It measures (i) density, (ii) growth, and (iii) migration, of population as indicators of demographic changes in mountain areas.

The first "state" indicator is the quantitative assessment of the condition and level of sustainable use of natural resources in mountain areas. The purpose of this indicator is to assess the condition or degree of stability, which is the clue of probable sustainability

of natural resource uses in mountain areas. It is also used to identify obvious land degradation and misuses that need policy responses. This indicator is a composite of four sub-indices that describe in broad terms the state or condition of the natural resource base in a mountain area, namely the extent of protection of soil, the area of hazard zones, the extent of degraded areas, and a measure of productivity.

The second proposed "state" indicator is welfare of mountain. The purpose is to use nutritional status as indicator of an overall and simple measure of human welfare and development. This indicator is focused on the nutritional anthropometry of children and adults in mountain populations as a measure of their overall welfare or well being, their level of prosperity or poverty, and changes in their welfare status.

However, these indicators are not necessarily applicable to the local conditions and modifications might be required. For example, measurement of nutritional level and the productivity of forest resources are not relevant to the situation and problems in CH.

2.3 Perspectives on Sustainable Mountain Development in Malaysia

2.3.1 National Commitment to Sustainable Development

After the Rio conference, Malaysia has incorporated the concept of sustainable development into the national planning process when the Sixth Malaysia Plan (1991-1995) was reviewed in 1993. In one of the goals of the Seventh Malaysia Plan, covering the period of 1996-2000, the commitment towards sustainable development was clearly written as the following:

"Ensuring sustainable development not only through greater awareness on the preservation of environment but also emphasizing the integration of environmental considerations in the economic and social development process" (EPU 1996)

The Seventh Malaysia Plan envisaged integration of economic, social and environmental factors into the development process and to ensure that improvements in living standards are made without compromising the needs, interest and welfare of the future generations. In the proposed National Environmental Policy, Malaysia will focus on the establishment of a strengthened institutional framework, enactment of relevant legislation and regulations, and creation of an efficient and effective enforcement and monitoring machinery.

The plan is also formulated to control pollution and implement better waste management. Environmental considerations will be integrated into land use planning to ensure sustainable land utilization and watershed protection. Guidelines and regulations will be drawn for soil conservation in high-risk areas such as mountain. Other activities and programs that will be incorporated into the plan are abatement and mitigation measures for land development; sustainable productive forest management; inventory and establishment of biodiversity and genetic resources databases; protection and conservation of critical habitat and integrated coastal zone planning.

The Malaysian government has also acknowledged the critical roles played by all the stakeholders in ensuring sustainable development. Environmental education and awareness programs, changes of consumption pattern and lifestyle are among the critical aspects in promoting sustainable development. Malaysian approaches will incorporate

command-and-control type of legislation with market mechanisms and economic instruments to achieve sustainability.

Mountain is among the various categories of natural resources identified for sustainable development in Malaysia. The main range of Peninsular Malaysia constitutes of hills and mountains with a few peaks that are more than 2,000 m. It is important as the watershed, pool of genetics resources and biodiversity, dwelling place of indigenous people, supply of forest products, and recreational destinations. Malaysia has identified the needs of strengthening management plan and conservation effort with international cooperation (UN 1997).

2.3.2 Legislation Pertaining to Sustainable Mountain Development

Although the Malaysian development plans outlined principles to achieve sustainable development, policies and guidelines that have been drawn up and laws that have been passed for integration of economic, environmental and social are still limited. There are numerous laws that are relevant to the conservation and environmental protection, but most of them are not drawn specifically for these purposes.

While analyzing the response of environmental management in Malaysia, Jamaluddin (2000) outlined 45 Acts that are relevant to the environment. He commented that the majority of the laws are sectoral based and not for the purpose of environmental protection (Jamaluddin 1991, 1996, 1999). Besides the Environmental Quality Act 1974, these laws were mainly for control and management of natural resources exploitation (Jamaluddin & Hasan, 1996). Hence, these laws do not address the problems of sustainable development, and specifically in mountain regions in a holistic manner.

There are numerous government agencies, with the empowerment of respective legislation, which are involved directly and indirectly in managing the development in mountain areas. Those agencies include Department of Agriculture, Department of Forestry, Department of Irrigation and Drainage, Department of Environment, Water Supply Board, Department of Town and Country Planning and Local Government (Noorazuan 2000). The mountain environment related legislation in Malaysia are discussed as the following:

a) Policies, laws and guidelines related to land are as the following:

1) Land Conservation Act 1960

This Act makes provision for gazettement of hill land in order to implement effective conservation measure. It also makes provision on the restriction of planting of short-term crops, land clearing and cultivation. Part III of the Act is made for control of silt and erosion for protection of land, especially steepland.

2) National Land Code 1965

This land code classified land into three land use categories as agriculture, building and industry.

3) Land Council Declaration 1996

The Land Council made a declaration that all land above 1000-m above mean sea level are classified as permanent forest reserves and land clearing is prohibited. It is not effectively implemented in the case of CH where land clearing activities are rampant.

4) National Agriculture Policy

This policy discourages opening of new land and calls for more effective use of existing land to increase productivity.

5) Soil-Crop Suitability Classification

This classification issued by the Department of Agriculture defines agriculture land as land having slope less than 20 degree. In 1998, the Department of Agriculture in collaboration with Malaysia Agriculture Research and Development Institute (MARDI) developed a new guideline for agriculture on steepland. Recommended soil conservation and agronomic required in various slopes are clearly stated in this guideline.

6) Environmental Quality Act (EQA) 1974

This act required environmental impact assessment to be carried out for prescribed activities. Prescribed activities for agriculture sector are spelled out for land ranging from 50 to 500 hectares. It is not effective in controlling small plot land clearing in mountain slope. Market gardening activities in CH are basically small holders farming in small plots of a few hectares of land. Section 24 imposes restriction on pollution of the soil or surface of any land with liquid, solid or gaseous pollutants. The regulation cannot be applied to control the use of pesticides and fertilizers in the agricultural activities in CH.

b) Policies, laws and guidelines related to forest are as following:

1) National Forestry Act 1984

This act stipulates on the administration, management and conservation of forest and forestry development. This Act makes provision for the State to gazette forested land into permanent forest reserve. There are different classifications and purposes of forestland such as for timber production, soil protection, water catchment, wildlife sanctuary, virgin jungle reserve, amenity, education and research forest.

2) National Parks Act 1984

This Act is to provide for the establishment and control of National Parks. The objective of the establishment of National Parks is the preservation and protection of flora, fauna and objects of geological, archaeological, historical, ethnological and other scientific and scenic interest and through their conservation and utilization to promote the education, health, aesthetic values and recreation of the people. There is no national park in CH.

3) Environmental Quality Act 1974

Section 29A prohibits any person to cause any fire, combustion or smouldering that occurs in the open air and open burning. Although, there is no burning of agriculture waste, but burning is practiced during forest clearing in CH.

c) Policies, laws and guidelines related to water are as following:

1) Environmental Quality Act 1974

Section 25 prohibits discharge or deposit of hazardous substances, pollutants or waste into inland waters in contravention of the acceptable conditions. It is not effective in controlling the use of pesticide in agricultural activities.

2) Street, Drainage and Building Act 1974, and Local Government Act 1976

Local authorities make provision on water pollution in their by-laws under the above law.

3) Waters Enactment 1920 (Revised 1989)

Management of development activities in water catchment areas.

Other relevant laws are the Aboriginal Peoples Act 1974, Pesticide Act 1974, Protection of Wildlife Act 1972 (Revised 1976), Mining enactment 1929, Forest Enactment 1935,

and Natural Resources Ordinance 1949. Besides, there were an agreement in 1959 between the TNB (the then National Electricity Board) and the State Government of Pahang Darul Makmur regarding the need to preserve, control and proper development of the hydroelectric catchment. The agreement contains numerous guidelines on the land development on hill slope such as methods of clearing natural vegetation, methods of establishing vegetative cover, selection of types of crops to be grown, choice of subsequent cultivation and mechanical methods of planting. However, these are not effectively implemented in restraining uncontrolled development and ensuring the adoption of proper methods of cultivation in CH (Choy and Omar, 1990).

However, there is no single legislation that deals with mountain ecosystem in an integrated and holistic approach. As all of these specific sectoral laws are in isolation and fragmented, they do not provide a comprehensive coverage on the issues encountered in mountain regions. Furthermore, legislative supports for implementing sustainable development strategies in a mountain ecosystem is lacking and consequently does not lead to effective management of the mountain environment and development planning.

2.4 Literature Review on Studies of the Cameron Highlands

In order to assess the situation in Cameron Highland, a literature review into the scientific reports as well as other relevant records of the study area is made. Even though Cameron Highlands (CH) is a small district as a hill station, it attracted tremendous attention from the scientific communities. Numerous publications and reports are available that examined various aspects of this mountain area. The reports encompass the status of its major anthropogenic activities and its environmental quality.

The main motivating factors are due to the fact that it is the country's major tea, temperate flower and vegetable production area and it is also the prime tourist destination as well as a catchments area for hydroelectric power generation. Moreover, this fragile mountain ecosystem is highly susceptible to soil erosion, landslides and ecological degradation. Environmental degradation such as soil erosion and landslides had claimed human lives and property, which had also attracted significant public attention.

2.4.1 The Development and Environment in CH

Leong (1992) wrote a qualitative account on the intensified development in CH and the consequential environmental problems. The expansion of tourism industries and the blooming of hotels and housing construction without proper soil conservation measures, the intensified and expanding agricultural activities on steep hill slope had deteriorated the environmental quality. He concluded that an appropriate development plan should be formulated, which recognizes the ecological constraint of the fragile mountain ecosystem and which is comprehensive enough to ensure long term sustainability of the highlands. Leong does not further elaborate on the plan with detailed strategies.

2.4.2 The Agriculture Development

Research on the agricultural sector in CH is extensive. Ko *et. al.* (1987) reviewed the status of agriculture in CH. The land area and its slope gradient, where various types of crops are grown, have been estimated. The production of vegetable and the income generated, the application of fertilizers and pesticides and the agronomic practices, and in general, the marketing system and vegetable prices were briefly presented. Tea, flower and fruit cultivation were also examined. The paper concluded with a discussion on the problems of cultivation in CH such as diseases and high input cost.

A comprehensive scrutiny of soil erosion and environmental impact of vegetable production by Midmore was published in a paper entitled 'Soil erosion and environmental impact of vegetable production in the Cameron Highlands, Malaysia' in 'Agriculture Ecosystem & Environment' (Midmore *et. al.*, 1996/a). This paper examined the changes in land use in the second half of the 1980's, followed by an assessment of the structure and the patterns of the vegetable farming and also the production volume and profitability. The main source of soil erosion problem was carefully studied; the physical extent and the externality cost associated were estimated. Field survey was performed to assess the farmers' attitude and the extent of adoption of soil conservation practices, as well as integrated pest management (IPM).

In another publication by Midmore *et. al.*, (1996/b) in the Technical Bulletin of Asian Vegetable Research and Development Center, he emphasized on the extent of adopting of erosion control practices in relation to the economic resources of vegetable farmers was made. The motivation factors for implementing or not implementing the soil conservation measure were also critically examined.

Purushothaman (1976) recorded fertilizer application practices of the farmers in CH. He concluded that the applications of organic fertilizer viz. chicken dung and prawn dust were excessive and wasteful. Among other researchers who reported on high fertilizer input in agriculture land were Ghazali *et. al.* (1994), Wan Abdullah *et. al.* (2000) and Wong *et. al.* (2000).

Cultivation of vegetable crops is susceptible to a number of pests and diseases. Midmore *et. al.* (1996/b) commented on the failure of the farmers to restrain pesticide application before harvesting was the main reason for the presence of pesticide residue

on market vegetable. There are significant trade implications if the vegetable is intended for the export market (NST, 08/01/1994; NST, 04/04/1994; NST, 20/07/1999; NST 07/10/2000). Ghazali *et. al.* (1994) studied the trends of agricultural chemical used by the cabbages farmers and the reason of higher use of inputs. The farmers' perceptions on possible impacts of reducing chemical applications were also assessed.

2.4.3 The Tourism Development and Environmental Impacts

Research on tourism in CH is limited. Leong (1992) commented that tourism industry has been identified as a major strategy for economic development in Malaysia and has resulted in the rapid expansion of recreational facilities and accommodations in CH. The trends were encouraged for the upper end of the tourist market, where the development of luxurious hotels, holiday homes was intensified to cater for the wealthy individuals and large companies. Sellam (1997) researched into the perception of arrived tourists on the climate, farming activities, natural ecosystem and the development of CH. He also discussed on the positive and negative impacts of tourism industry in CH.

2.4.4 The Degradation of Environmental Quality

Long-term climatic changes in CH have not yet been studied in details. However, Wong (1999), Leong (1992) and Sellam (1997) had made records of the newspaper reports and farmers' perceptions on the temperature rise in this mountain area. A more detailed study of rainfalls and temperature records over the past four decades by Midmore *et. al.*, (1996/b) supported the local perception of rising air temperature and diminishing rainfall. Midmore compared the maximum and minimum average temperature of 1954 – 1972 with those 1980 – 1989. The results indicated reducing maximum average

temperature and increasing minimum temperature. For the similar temporal range of comparison, average rainfall of later years is also indicating a diminishing trend.

Landslide and soil erosion are the common problems in mountain areas with steepland and high rainfall. The severity of soil erosion is well supported by the heavy silting of Ringlet Reservoir. These problems have been frequently reported in various studies such as Roslan *et. al.* (1996), Midmore *et. al.*, (1996/b), Choy and Hamzah (1997), Wong (1999), Aminuddin *et. al.* (1999/a) and Wan Abdullah *et. al.* (2000). The sedimentation problem in the Ringlet Reservoir has not only increased the operational costs of the hydroelectric scheme but has also threatened the operation of the reservoir.

The degradation of soil quality due to salinization (Wong *et. al.,* 2000) and heavy metal contamination (Zauyah *et. al.*, 2000) posed the question of sustainability of high input farming in CH. However, the study of soil quality is still limited. Midmore *et. al.*, (1996/b) reported that farmers resurface their soil periodically (4 to 10 years), due to poor yields, poor soil, weeds, diseases and flooding. Beds also need to be remade every 22 weeks due to poor soil and low vegetable yields.

Water quality study preformed in CH is limited. Wan Marina (1990) sampled river water in seven stations in CH and tested for various physical and chemical properties compared with the presence of algae species. He concluded that algae that live in polluted waters are present in most of the rivers in CH besides the only pristine sample. Norhazni & Pauza Hanum (1996) surveyed five rivers in CH and concluded that those rivers are highly contaminated with various pollutants in the rivers. Aminuddin *et. al.* (1999/b) reported considerable amount of nutrient losses to leaching and surface runoff in agriculture activities.

2.4.5 Overall Observation from the Literature Review

The scientific studies and researches in CH are extensive, but are mostly concentrated on specific aspects on agriculture and its related disciplines. These research studies highlighted associated deterioration in environmental quality. Based on these scientific reports, there are significant evidences on the deterioration of environmental quality. However, these studies are limited to a specific narrow scope of the subject matter. Furthermore, there are gaps of environmental problems that do not receive sufficient treatment to reveal its degree of deterioration.

Besides general papers that discussed on the environmental problems in CH, there is not a single comprehensive study that employed sufficient quantification of the subject matter from multiple perspectives. No attempt has been made to provide a holistic and integrated overview on the interaction of environmental and anthropogenic activities in this fragile mountain ecosystem.

As the various components in this mountain ecosystem is strongly integrated and interrelated, a holistic treatment to the subject is required. A multi-disciplinary understanding of the ecosystem is therefore very important and crucial for the decision-makers of policies, development and environmental plans, the implementers of these plans as well as the local communities of this mountain region.