Chapter Seven

DISCUSSIONS AND CONCLUSIONS

Chapter 7.0 Discussions and Conclusions

Human interventions into this highly sensitive and fragile mountain natural system have induced tremendous stress on the natural mountain ecosystem in the Cameron Highlands. In the earlier chapters, it has shown that significant deterioration of environmental quality in the hydroelectric catchment of Cameron Highlands has occurred. The impacts of the deteriorated environmental quality have also been assessed.

The major pressures and the resultant environmental degradations in the hydroelectric catchment are summarised and discussed in the following sub-sections. Then, discussions of the sustainability will be presented. The responses of the society towards the environmental degradation will also be reviewed in this chapter. This study will recommend mitigation measures in response to the major pressures and environmental degradations. Lastly, long-term management strategies and further scientific studies are recommended for this mountain ecosystem.

7.1 Sustainability of the Hydroelectric Catchment

7.1.1 Development Pressures

Development activities utilize natural resources of this fragile mountain and induce stress on the ecosystem. If the magnitude and frequency of the stress is higher than the amplitude and elasticity of the ecosystem, the stability will break down. The ecosystem might then degrade to a new equilibrium that is inferior in quality and lower in productivity. Based on this concept of ecosystem dynamics, the pressures exerted by the major anthropogenic activities are summarized and the impacts of those activities will also be presented.

a) Agricultural Activities:

The demand for agricultural products and the government plan to increase agricultural output encourages rapid expansion of market gardening in the 1990's. Favorable climate and lucrative returns, especially in floriculture, are also among the motivation factors that encourage the expansion of farming activities in the highlands. Agricultural activity provides 64% of total job available in Cameron Highlands in 1995. The export value for cut flower was RM80 million in 1995. In 1999, vegetable production was worth more than RM180 million at the wholesale market and the off factory's value for tea was RM27 million.

Land use for market gardening in the hydroelectric catchments increases drastically from 1743.4 ha in 1990 to 3048.6 ha in 1997. It is expected to further expand as the accessibility to the forest is increased, due to construction of new roads and highways. The extensiveness of illegal forest clearing for agricultural activities in Cameron Highlands exacerbates the problems in control and management of land use.

There are only 8.6% of land, which has a slope of less than 6° in the hydroelectric catchment. Nevertheless, the agricultural land constitutes 25% of the total land area and with about 66% of the market gardening land located on slopes greater than 12°. Thus, heavy erosion and landslide are expected in the area of high slope, where short-term crops such as vegetable are cultivated.

The large-scale transformation of forest to vegetable farms has altered the surface characteristics, hydrology and modified the soil contents of this mountain catchment.

It can be expected that there will be increasing occurrences of natural disasters such as landslides, floods and draughts as well as losses in the productivity of the catchment.

On the other hand, poor agronomic practices and poor field management of the farms pose enormous stress on the environment. These poor farming practices begins at land clearing to harvesting such as massive forest clearing, contour modification, poor soil conservation practices, excessive fertilizer input, heavy application of pesticide and unsuitable cropping cycle. Various studies had indicated that the majority of the farmers do not adhere to agronomic practices recommended by the Department of Agriculture.

Large area land clearing by using heavy machinery and contour modification causes loss of topsoil and generates large amount of loose soil, which is very easily eroded by running water. Soil erosion is not only detrimental to the fertility of the land but also causes damage to downstream waterways and ecosystems. Moreover, there are indications of no coordination on water utilization and rainwater management among the adjacent farms.

Due to poor soil conservation, farmers are forced to remake crop beds and to apply more fertilizers. The fertilizer input is higher than the recommended amount and is increasing at a rapid rate. Expenditure of manure accounts for 50% of the total material costs. Newspapers reported farmers complaining of unable to compete with the imported vegetable due to the high costs incurred from the application of fertilizers and pesticides. During periods of excessive supply, farmers were forced to destroy thousands of tons of vegetables in order to boost the price.

The quality of vegetable has also suffered due to high levels of pesticide residues that indicate the extensive use of pesticides. Soil health and heavy metal contamination is also at an alarming stage in floriculture industry. Another impact of great significant but as yet undetermined is the health impact of pesticide application on the farmers. The implementation of Integrated Pest Management was not well received by the farmers.

The agricultural activities have thus imposed enormous stress on the land and water system in Cameron Highlands. The stress on the environment can cause irreparable damage to the environment and in the long run, it will undermine the agricultural activities. As the long-term sustainability of agriculture is crucial for the welfare of the local communities, further development of agriculture should give sufficient consideration on the stability of this fragile mountain ecosystem. Over exploitation and bad management can undermine the stability of the mountain ecosystem as well as the productivity of the agricultural sector and other anthropogenic activities.

b) Development in Tourism Industry:

Tourism is an important industry in Cameron Highlands. It brings in resources to the mountain regions and contributes significantly to diversifying the economic activities. The average annual tourist receipts was RM132 million in the 1990's. Tourism industry also contributed about 10% of the job market. In addition, many supporting industries are blooming due to the expansion of tourism industry. However, improper development of tourism causes environmental as well as social stresses.

The total number of tourist per year is projected to increase from 320,000 in the year 1995 to 3,500,000 in 2020. The ratio of tourists to local population will increase from 2.6% in 1995 to 18.7% in 2020. The increase will definitely impose social pressures on the local community. On the other hand, development of tourist facilities, infrastructure and hotels is expanding at a rapid rate. Local participation and ownership in the industry is rather weak as increasing number of luxurious hotels are owned by multinational groups, big bungalows are owned by wealthy individuals and companies as well as the purchase of apartments by seasonal tourists.

However, the tourist arrival is maintained at an average of 275, 000 in the second half of 1990. The unrealistic projection has encouraged over development of properties and hotels. Hotels average occupancy rate had also dropped tremendously from 74.2 to 35.7% in 1992 to 1997. The length of stay had also decreased by about 50% in the same period of time. The saturation of tourism industry also forced the state government to freeze all hotel development for 3 years since July 1997.

The development of tourist facilities induces various damages and changes to the mountain ecosystem such as deforestation, visual pollution, and changes in hydrological elements, surface albedo and severe soil erosion during construction. Besides, other environmental degradations include the increase of waste generation and residue, traffic congestion and emission and degraded water quality.

In general, development pressure is mounting as the population is estimated to increase from 28,000 in the year 1995 to 50,000 in the year 2020. The in-migration rate was as high as 9.8% in 1986-1991. This is due to increase job opportunity in tourism industry, construction, new farmland and other servicing industries. The

rapid expansion of build environment and the road network will fragmentize the remaining forest area and induces greater stress on the natural system. Due to poor soil conservation measures during construction, it also contributes significantly to the erosion. These activities, especially the road network expansion will further induce other developments such as the encroachment into previously inaccessible forestland.

The importance of tourism industry is recognized for the diversification of the economy of this mountain area. It has contributed significantly to the welfare of the local community. However, all the negative impacts of tourism have now exerted enormous stress on the natural environment. There are indications of negative impacts of the changes in environmental quality that have undermined the sustainability of tourism industry itself as well as other anthropogenic activities and natural heritage. The development should not advance in the mist of unclear carrying capacity of this fragile ecosystem.

c) Hydroelectric Power Generation:

Hydroelectric power generation in Cameron Highlands contributes to meeting the peak load in the daily national power demand profile as well as the normal base power load. The annual energy output of the Cameron Highlands-Batang Padang hydroelectric scheme is about 872 GWh. The annual revenue is estimated at about RM170 million. It not only contributes to the national power demand but also the local economic and social welfare. Even though the construction of the hydroelectric scheme had irreversibly disturbed the mountain ecosystem, the continued operation of this setup has to be protected.

At the moment, the sustainability of this hydroelectric scheme is being threatened. The productivity of the run-of river power stations has been reduced. Due to high sediment load in the rivers, power generation at the run-of river power stations have to be halted very frequently in order to avoid damages to the mechanical parts. The capacity of these hydropower generation plants is deteriorating and the operation cost is increasing. The average annual energy output of the mid 1980's to the early 1990's was 0.13 kwh/m^3 of runoff water compared to 0.18 kwh/m^3 in the 1960's and early 1970's in Robinson Falls Power Station. Other run-of river schemes have also suffered similar setback.

In the year 1999, a total sediment deposit of more than 3.5 million m^3 had reduced the live storage of the Ringlet Reservoir from the designed 4.7 million m^3 to 2.8 million m^3. Furthermore, due to heavy sediment load, the minimum operating level of the reservoir has also been progressively increased. The increase in minimum operating level has further reduced the effective storage capacity of the reservoir to 1.8 million m^3. This effective storage is below the minimum storage capacity of 2.09 million m^3 required for optimum load peaking operation. On the other hand, at the present estimated rate of siltation, the reservoir will cease to operate in five to seven year's time. Besides the loss of storage capacity, it will pose a threat of loss of load peaking capacity for power generation in the Jor and consecutively the Woh Power Station. TNB will suffer RM95.4 million per year if both stations are forced to operate as run-of river schemes. Moreover, TNB will then be forced to look for alternative power source for load peaking function, which can be more environmental unfriendly and costly.

In order to mitigate the problem, TNB has implemented a few measures such as construction of desander and weir to trap sediment and excavation of sediment at various locations. It is estimated that the excavation cost is about RM2 to 3 million per year. Recent planning of large-scale excavation operation of the reservoir is expected to cost more than RM100 million. Moreover, there are environmental issues such as the transportation and the storage of the excavated sediment.

The evidences suggest that the operation of hydroelectric scheme faced enormous pressure. The operational cost is increasing while the production is reducing. Therefore, long-term sustainability of the scheme is under threat. On top of the destruction to the mountain ecosystem, other development activities in the hydroelectric catchment are unsustainable in view of the hydroelectric power generation, which is one of the important resources of Cameron Highlands.

7.1.2 Environmental Quality Changes

An ecosystem is expected to have its own capacity to assimilate a certain degree of disturbance. As discussed earlier, if the disturbance or stress is more than the self-repairing capacity, the stability of the ecosystem will break down. The biotic and abiotic components of the ecosystem will change in order to achieve another equilibrium, which might become inferior in quality such as biodiversity, productivity and ecstatic value. In response to the pressures of development, the environmental quality has changed through time in Cameron Highlands. These changes are summarized and its impacts are also presented in the following.

a) Deforestation:

Reduction in forested area is one of the key factors that contributed to the changes in the biological and physical system of the catchments such as biodiversity, climatic elements, hydrology regime, slope stability and soil erosion. In 1947, forested area represented 95% of the total hydroelectric catchment area of 17,100 ha in the Cameron Highlands. The forest cover was reduced to 62% in 1997. In the Telom hydroelectric catchment, the forested area was reduced drastically due to accelerated conversion to agricultural land between 1990 and 1997. The area of forest cover was reduced from 80% to 64% in that short period of time.

Besides the changes to the physical system, reduction in forested area has great impacts on the species richness and diversity of flora and fauna in this mountain catchment. It is also expected to threaten the livelihood, traditional knowledge and cultural survival of indigenous communities, who live in the forest for centuries.

b) Local Climatic Changes:

Long-term trend seems to indicate an increase in the surface air temperature and a reduction of precipitation for the period of 1949 to 1997. The magnitude of increase in mean daily temperature was 0.6°C in 25 years. The mean daily temperature had increased by 1.5° C at the Habu power station and 0.6° C at Tanah Rata. The absolute lowest temperature at Tanah Rata showed a significant increasing trend of more than 3°C. The linear trend analysis indicated a nearly 2°C increase for the mean minimum temperature and 1°C upward trend for mean maximum monthly temperature in Tanah Rata. Trends of monthly temperature anomalies also indicated positive

deviation from long-term reference mean. Thus, temperature data provided sufficient evidences of warming trend in Cameron Highlands.

For the same period of time, rainfall also suggested a reducing trend of an average of 4.4 mm/year for the last 50 years at the Bertam catchment, representing a loss of 220 mm or 8.9% of the long-term mean annual rainfall of 2,444 mm/year. Similarly, the Telom catchment also experienced a reducing trend of 2.4 mm/year, representing a loss of 120 mm or 5.3% of mean annual rainfall of 2,280 mm/year. Analysis of rainfall anomalies indicated an increasing frequency and severity of annual rainfall deficiency in the last two decades when compared to the 50s and 60s. Even though rainfall data showed greater fluctuation, the reducing trends are observed.

It is likely that these changes are due to localized loss of forest cover, enlarged cultivated plots, increased urbanization and other anthropogenic activities. The potential impacts of changes in rainfall and air temperature on human (both residents and tourists), crops and natural system as well as power generation have yet to be established. The increase of air temperature may have negative effects on the quality and productivity of the agricultural products. On the other hand, it may also alter the natural vegetation in Cameron Highlands.

c) Conflicting Water Usage:

There are competition in water usage for power generation, irrigation and domestic consumption. Increasing abstraction of stream water for irrigation and domestic usage reduces the water availability for power generation. One of the water intake points in Kodol River dried up due to heavy abstraction of water for irrigation especially in the dry seasons. The situation is expected to deteriorate as the measured

streamflow suggests a reducing trend. Long-term records of streamflow for both Bertam catchment and Telom catchment are reduced at an average rate of 7.2 mm and 1.6 mm/year respectively. This is expected due to the decrease in rainfall over the years. On the other hand, the effects of deforestation in Telom are clearly demonstrated by the smaller reduction of average streamflow when compared to Bertam. The streamflow to rainfall ratio is increased in Telom catchment due to lower water holding capacity for the catchment.

d) Deteriorating Water Quality:

Mainly due to heavy suspended load, the Water Quality Index published by Department of Environment for Bertam River shows deteriorating trend. Suspended Solid, Ammoniacal Nitrogen and Iron contents in Ringlet River exceeded limits set in Water Quality Standard Class III. Nutrient Phosphorous and Nitrate concentrations in most of the major rivers are more than those specified in the Water Quality Standard Class III.

Increasing suspended solid load is the most critical problem of most of the river in Cameron Highlands. Average suspended load concentration in Telom River increase from 15 ppm in the 1960s to 251 ppm in the 1990s. On the other hand, average suspended load in Upper Bertam River increased 15 fold from 15 ppm in the mid 1950s to 231 ppm in the 1990s. These changes have significantly deteriorated the water quality of this mountain area.

The immediate impact of water quality deterioration is the aquatic life. Studies showed that species that live in clear water are no longer presence in most of the river in Cameron Highlands. The river ecosystem is expected to suffer great losses in

species diversity. On the other hand, there are long-term effects on the communities who depend directly and indirectly on the river ecosystem. In addition, there are accumulated downstream impacts, which have yet to be assessed.

e) Severe Soil Erosion:

Due to poor farming practices and poor soil protection in road and building construction, soil erosion is very severe in hydroelectric catchment of Cameron Highlands. Estimated total soil erosion contributed by the market gardening is at the rate of 230 – 260 ton/ha/yr. Other major sources of erosion, besides the yearly average contribution by market gardening, are earthworks and contour modifications in land clearing and construction works. On the other hand, the estimated average soil erosion yield rate for the entire hydroelectric catchment was 46.7 ton/ha/yr in 1997. The soil erosion rate for the catchment is among the highest of the tropical catchments.

Besides the damage to the waterway, the most significant impact of soil erosion in Cameron Highlands is the siltation of the Ringlet Reservoir, which causes TNB to suffer great economic losses. The loss of topsoil has reduced the fertility of the soil and forces the farmers to increase the usage of chemical fertilizers and organic manure. This has significantly increased their material costs and reduced their competitiveness. The most dangerous consequence of losing soil fertility might lead to the ultimate destruction of the biological potential of the land and a wide spread deterioration of the ecosystem.

f) Loss of Flood Control for Ringlet Reservoir:

As the reservoir losses its storage capacity, the buffer to delay flood is diminishing. At 70 mm of 24-hr rainfall, there will be a forced spillage of the reservoir, if there is a corresponding intake of 46% of the Telom streamflow at the Telom Tunnel. At 80 mm and 100 mm of rainfall, reservoir spillage will occur with only a corresponding 32% and 13% intake respectively from the Telom Tunnel. The risk of flash flood is very high, which poses danger to human lives and properties, and should be mitigated immediately. The illegal farming activities on the river reserve at the downstream of Bertam River will have to be relocated. Furthermore, the likely effects on human and river ecology of the sediment load and the polluted chemical contents of the river water flowing eastwards instead of westwards to the downstream areas have yet to be established.

g) Increasing Risks of Flooding and Landslides:

The computed unit hydrograph for the Telom catchment suggests an increase of discharge volume of about 8% with a time to peak shortened by about 35 minutes for the year 1974 to 1997. Severe landslides have been reported in the literature and newspapers. The main causes of landslide are the road and building construction, as well as due to the encroachment of short-term crop cultivation into the steep slope terrain of the catchment. Cultivation on slope more than 6° had increased from 236 ha to 2,636 ha from the year 1947 to the year 1997. This changing trend of land use has tremendously increased the risk of soil erosion and landslides.

7.1.3 Sustainability of Cameron Highlands

The summaries in the above 2 sub-sections clearly demonstrate that the hydroelectric catchment of Cameron Highlands is facing tremendous development pressure and suffers severe environmental degradation. The deterioration is mainly due to the intense pressures and unsound management of the anthropogenic activities, such as those in agriculture and tourism. The definition of sustainable development rests on meeting own needs without compromising the ability of the future generation to meet their needs. Under this basic definition, the development in Cameron Highlands is unsustainable as discussed above. The degradation in environmental quality in Cameron Highlands has not only undermined the economic and social welfare of the today community but also undermines the ability of the future generations to meet their needs. The welfare of the future generations has been compromised because of the irreversible damage to the environment.

On the other hand, the consumers have to bear unknowingly the potential health risk due to high pesticide residues in vegetables that they consume. The society and particularly the operator of hydroelectric scheme have to bear the costs of soil erosion. The innocent farmers and local population risk their lives and properties due to flash flood and landslides. These are examples of development, which are against the polluter pays principle of sustainable development. The polluters are granted the benefit of the destruction of the environment without internalizing the cost of pollution. This weakness of the development will accelerate the destruction of the environment.

With respect to the precautionary principle of sustainable development, the development in Cameron Highlands is also unsustainable. The development activities in Cameron Highlands ignore the possible negative effects in the process of exploitation of

the natural resources. There are scientific uncertainty on a few issues such as the direct relationship of development to the local climate, the long-term effects of soil erosion and heavy pesticide application on soil health and fertility as well as the unknown carrying capacity of this mountain region. However, development planning has not adopted a precautionary approach, especially in this highly sensitive ecosystem, in order to avoid disaster and to ensure sustainable development.

Hence, long-term sustainability of the hydroelectric catchment is questionable. Development should not be taken as only in a single purpose of economic progress but must bear a holistic perspective in terms of economic, social and also environmental dimensions. Therefore, immediate action is required to respond to the situation before it is too late and too costly if not impossible to save this mountainous catchment.

7.2 Societal Responses on the Environmental Degradation

Within the Pressure-State-Response framework, societal responses refer to individual or collective actions to mitigate, adapt to or prevent human-induced negative impacts on the environment (OECD, 1993). With the information of the pressure (human activities) and the state of the environment, the society makes decisions and actions as a feed back to control the pressures. These efforts can come from all levels of the society such as international, national, sectoral, enterprises and households. The societal responses also include the efforts to halt or reverse the environmental damages that had already been inflicted as well as the actions for the preservation and the conservation of the environment and natural resources.

The problems and issues of the development in Cameron Highlands are well known in the Malaysian society as it is widely covered in the local newspapers. Rigorous studies and conferences have already identified the problems in Cameron Highlands. On the other hand, there have been numerous policy and regulation changes in response to the deterioration. These include the adoption of guideline of steep land farming by the Department of Agriculture, the halting of hotel development by the state government of Pahang and the setting up of pesticide testing facilities. At the same time, there are a number of grass root movements such as the environmental awareness education and watchdog roles played by local NGOs as well as establishment of organic farming groups.

However, these societal responses are rather weak and unorganized. There is lacking of a consolidated societal response to overcome the challenges of this major environmental degradation. There are no measurable objectives or quantitative means such as indicators to check and feedback on the effectiveness of societal response in tackling such environmental problems in systematic and holistic approaches.

7.3 Management of the Hydroelectric Catchment

7.3.1 Management Needs

Since the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992, the recognition of the importance of managing mountain ecosystem has been gaining global attention in recent years. The management framework suggested should be in line with Chapter 13 of Agenda 21, entitled 'Managing Fragile Ecosystem: Sustainable Mountain Development'.

Mountains are an important source of water, energy and biological diversity. Furthermore, they are a source of such key resources as minerals, forest products, and agricultural products and of recreation. As a major ecosystem representing the complex and interrelated ecology of our planet, mountain environments are essential to the survival of the global ecosystem. As this fragile ecosystem is located in a high potential energy region, it is prone to rapid changes. Mountain areas are susceptible to accelerated soil erosion, landslides and rapid loss of habitat and genetic diversity. As a result of improper human intervention to this nature ecosystem, most global mountain areas are experiencing environmental degradation.

All the major anthropogenic activities in Cameron Highlands are significant in political, social and economic dimensions. The inter-relationship amongst these activities, mainly power generation, tourism and agriculture, and their interdependence with the natural, physical, chemical and biological environment has been clearly demonstrated. The economic and social importance of highland vegetable farming, tourism and hydroelectric power generation has already been demonstrated too. The livelihoods of all the local such as the farmers, tourism operators and also the servicing industries that supply inputs, transports and marketing of the products have to be protected. On the other hand, hydroelectric power generation, which is a relatively green power production compared to fossil fuel, should be sustained without incurring higher operational costs as a result of the deterioration of environmental quality.

7.3.2 Recommended Mitigation Measures

The proper management of mountain natural resources and socio-economic development of the people deserves immediate action with critical management strategies to ensure sustainable mountain development in Cameron Highlands without depriving the right of future generations. In view of the severity of the environmental degradation as analysed in the above, some suggestions for management and mitigation of the environmental degradation in Cameron Highlands are the following:

- To increase health and environmental awareness of the local population and the farmers in particular.
- To transfer soil conservation technology, Integrated Pest Management Practice, effective fertilizer application practice and other suitable agronomic practices. Sufficient awareness and training should be disseminated widely. Among the objectives are to have the farmers to take the initiatives to manage the farms in environmental friendly manners.
- To control the usage of pesticides and to encourage organic farming.
- To improve marketing strategy of conventional farming and organic farming.
- To halt land clearing and development activities until carrying capacity has been defined.
- To prohibit massive land clearing and contour modification in both agriculture and construction.
- To restrict movement of any heavy machinery for large scale land clearing.
- To mitigate any bare-land and slope with high erosion risks by planting of cover grass and trees.
- To control the in migration of low land farmers into the highland.
- To promote eco-tourism with low stress to the nature.
- To promote agro-tourism with farm stays.

7.3.3 Management Strategies

On the other hand, long-term management strategies are also required in order to strengthen the institution, knowledge base and human resources base in the effort of achieving sustainable development in Cameron Highlands. Five crucial strategies for sustainable management of fragile mountain ecosystem are recommended:

- Strengthen existing institutions or establish new ones at the local levels to generate a multidisciplinary land/water ecological knowledge base on Cameron Highlands. Existing institutions are disciplinary and divergent;

- Promote national policies that would provide incentives to local people for the use and transfer of environment-friendly technologies and farming as well as conservation practices. It is important to have legislation that focus on issues specifically for mountain regions in a holistic manner;

- Build up the knowledge base and understanding by creating mechanisms for cooperation and information exchange among local, national and regional institutions working on the mountain ecosystems in general and Cameron Highlands in particular;

- Establish appropriate natural reserves and state parks in representative species-rich sites and areas, and

- Human resource development in scientific and technological researches. Provides training in higher education center and undertaking environmental and conservation education programs for local residents and farmers.

7.3.4 Further Studies

Besides, specific information on ecology, natural resource potential and socio-economic activities are essential to assist better and in-time management decisions to be made. Thus, the creation of a database is vital for the understanding of the characteristic of the catchments and its carrying capacity in order to achieve sustainable development. Although this study has fulfilled substantially some major aspects of the data that is required, more comprehensive, long-term and holistic database is recommended for a better understanding of Cameron Highlands. This includes:

- To undertake a survey of the forest, plant and animal resources of Cameron Highlands. To determine the diversity and biological resources of the mountain regions;

- To undertake survey on agriculture and establish indicators for monitoring the sustainability of the various agricultural activities in Cameron Highlands.

- To undertake survey on tourism and establish indicators for monitoring the sustainability of the various tourism development and activities in Cameron Highlands. To encourage and ensure sustainable practice in eco- and agro-tourism.

- To implement policies and guidelines that granted local participation and benefit in all the development activities.

- To maintain and generate database and information systems to facilitate the integrated management and environmental assessment of Cameron Highlands, including to facilitate an evaluation of environmental risks and natural disasters by identify hazardous areas that are most vulnerable to erosion, floods and landslides;

- To improve and build on the existing land/water ecological knowledge base regarding technologies, agriculture and conservation, with the participation of local communities;

- To maintain and integrate meteorological, hydrological and physical monitoring analysis and capabilities that would encompass the climatic diversity as well as water distribution;

- To establish sustainable indicators for environmental, economic and social for Cameron Highlands and implement a long-term monitoring and evaluation programs;

- To involve local in decision making and implementation of policy, guideline, programs and activities. Participation of local communities is critical for success.

7.4 Conclusions

Overall, it does appear that the rapid development without proper conservation measures of the agriculture, tourism and infrastructure development has created tremendous externalities on the natural system. The externalities should be mitigated with sound management of the mountain catchments to ensure long-term sustainability of all the three important activities of the Cameron Highlands. Besides, a good management plan should integrate a holistic and multi-disciplinary framework with regional perspective in its view.

Thus, the management of Cameron Highlands should no longer be considered as a purely technical and economic single purpose challenges and opportunities. An integrated approach is needed for conserving, upgrading and using of the natural resource base of land, water, plant, animal and human resources. The development of a proper management framework in the Cameron Highlands can also later be applied to other mountain regions, as development in these regions are likely to occur in the future in other parts of the Main Range of Peninsular Malaysia as well as in Sabah and Sarawak.

This study is a combination of review of scientific research and analysis of economic, social and environmental aspects of the hydroelectric catchment of Cameron Highlands. This study also concludes that the present rate of development in the Cameron Highlands is not sustainable due to mounting development pressure and severe environmental deterioration. Its development trends are against the basic concepts and principles of sustainable development. However, this is only a preliminary study on the sustainable development in Cameron Highlands. Suggestions made at the conclusion are inclusive of a more detailed study and the implementation of management strategies as well as the long-term monitoring programs.