M A L A Y S I A

Second National Communication to the UNFCCC

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SECOND NATIONAL COMMUNICATION TO THE UNFCCC

This report is Malaysia's Second National Communication (NC2) submitted to the United Nations Framework Convention on Climate Change (UNFCCC).
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Units

mm	millimeters
cm	centimetre
m	metre
km	kilometre
km^2	square kilometre
ha	hectare
m^3	cubic metre
mcm	million cubic metres
g	gramme
kg	kilogramme
t	tonne
Gg	gigagramme
Mt	million tonnes
toe	tonnes of oil equivalent
ktoe	kilo tonne of oil equivalent
Mtoe	million tonne of oil equivalent
tCO_2e/ tCO_2eq	tonnes of carbon dioxide equivalent
kWh	kilowatt hour
kWp	kilowatt peak
MW	megawatt
MWh	megawatt hour
MWp	megawatt peak
RM	Ringgit Malaysia (Malaysian Ringgit)
M	million
C	Celcius
$mgCO_2m^{-2}s^{-1}$	miligram CO2 per square meter per second
$\mu mol\ m^{-2}s^{-1}$	micro mol per square meter per second

Gases

CO_2	carbon dioxide
CH_4	methane
N_20	nitrous oxide

Conversion Table

1 Tonne	=			10^3 kg	=	10^6 g
1 k Tonne	=	1 Gg	=	10^6 kg	=	10^9 g
1 M Tonnes	=	10^3 Gg	=	10^9 kg	=	10^{12} g
1 km^2	=	100 hectares				

List of Acronyms

APS	All Plausible Scenario/Alternative Policy Scenario
BAU	Business As Usual
BIPV	Building Integrated Photo Voltaic
CDM	Clean Development Mechanism
CETDEM	Centre for Environment, Technology and Development, Malaysia
CH_4	Methane
CO_2	Carbon dioxide
CO_2e/CO_2eq	Carbon dioxide equivalent
COP	Conference of Parties
DID	Department of Irrigation and Drainage
DOE	Department of Environment
DOS	Department of Statistics
EE	Energy Efficiency
EEC	Energy Efficiency and Conservation
EPU	Economic Planning Unit
FDPM	Forestry Department Peninsular Malaysia
FRIM	Forest Research Institute Malaysia
GAW	Global Atmospheric Watch
GCM	Global Climate Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Green Energy Office
GHG	Greenhouse Gas
GWP	Global Warming Potential
ICT	Information and Communications Technologies
IMR	Institute of Medical Research
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
ISMP	Integrated Shoreline Management Plan
IWRM	Integrated Water Resources Management
JBA	Department of Water Supply/Jabatan Bekalan Air
JPSPN/NSMWD	National Solid Waste Management Department/Jabatan Pengurusan Sisa Pepejal Negara
LEAP	Long Range Energy Alternative Planning
LEO Building	Low Energy Office or the Ministry of Energy, Green technology and Water
LULUCF	Land Use, Land Use Change and Forestry
MADA	Muda Agriculture Development Authority
MARDI	Malaysian Agriculture Research Development Institute
MBIPV	Malaysian Building Integrated Photovoltaic
MCB	Malaysian Cocoa Board
MGTC	Malaysian Green Technology Corporation or GreenTech Malaysia/ Pusat Teknologi Hijau (formerly Malaysia Energy Centre or Pusat Tenaga Malaysia/PTM)
MIEEIP	Malaysian Industrial Energy Efficiency Improvement Programme
MMD	Malaysian Meteorological Department
MOA	Ministry of Agriculture

MOH	Ministry of Health
MOT	Ministry of Transport
MPOB	Malaysian Palm Oil Board
MRB	Malaysian Rubber Board
NA1	Non Annex 1 (Developing country parties to the UNFCCC)
NAHRIM	National Hydraulic Research Institute of Malaysia
NC2	Second National Communication
NCSA	National Capacity Self Assessment
NCVI	National Coastal Vulnerability Index
NRE	Ministry of Natural Resources and Environment
NRW	Non revenue water
NSP	National Strategic Plan for Solid Waste Management
PM	Peninsular Malaysia
PRECIS	Providing Regional Climates for Impacts Studies
PTM	Pusat Tenaga Malaysia (now known as Malaysia Green Technology Corporation or GreenTech Malaysia/Pusat Teknologi Hijau Negara)
PV	Photovoltaic
R&D	Research and Development
RCM	Regional Climate Model
RegHCM-PM	Regional Hydro-Climate Model for Peninsular Malaysia
RE	Renewable Energy
SLR	Sea Level Rise
SREP	Small Renewable Energy Programme
TNB	Tenaga Nasional Malaysia
UKM	Universiti Kebangsaan Malaysia
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
V&A	Vulnerability and Adaptation

FOREWORD

It gives me great pleasure to present to you Malaysia's Second National Communication (NC2) to the United Nations Framework Convention on Climate Change (UNFCCC). This document reports the national greenhouse gas (GHG) inventory of Malaysia for the year 2000 and contains other relevant information on current and planned adaptation and mitigation measures in Malaysia, building on the information presented in our Initial National Communication (INC).

As a signatory to the UNFCCC, Malaysia has an obligation to report its GHG inventory to the UNFCCC. Malaysia takes this obligation very seriously. Consequently, every effort has been made to ensure that the document is comprehensive in its coverage, accurate in its reporting and contains the most recently updated historical data. The GHG inventory takes into account many sources of emissions and removals that were not included in the INC. The net result is a national communication document that far more realistically reflects the GHG emissions and removals in the country for the year in question.

The NC2 also uses current and historical data to project future emissions to initiate the process of planning and implementing emissions reductions strategies that will have the greatest impact. At COP 15 in Copenhagen, our Prime Minister announced that Malaysia would voluntarily reduce its emissions intensity of GDP by up to 40% based on 2005 levels by 2020. This initiative, which is conditional on technology transfer and financial support from developed countries, demonstrates Malaysia's willingness to address GHG emissions in the context of sustainable development.

At the same time, however, these measures need to be balanced with Malaysia's need to continue to grow to increase its per-capita productivity and income, eradicate poverty and raise living standards. This priority for continued development is one that is shared by the entire developing world and not surprisingly therefore is also enshrined explicitly in the preamble of the UNFCCC. In this regard it is also recognised that climate change impacts can adversely impact development and need to be addressed, hence underlying the critical importance of adaptation. The NC2 assessment identifies areas that Malaysia's climate change adaptation efforts should focus on to build resilience against potential impacts. I note with pleasure here that my Ministry recently launched the National Policy on Climate Change to ensure climate-resilient development. The policy also provides the overarching framework through which recommendations made in documents like the NC2 can be pursued.

Malaysia's NC2 would not have been possible without the cooperation of numerous experts and stakeholders and the contribution of copious data from many ministries, government agencies, research institutes as well as institutes of higher learning, Intergovernmental organizations and non-governmental organizations. My sincere thanks also go to the members of the Steering Committee as well as to the many subcommittees and working groups that have worked tirelessly to compile and edit this document. Finally my heartfelt thanks to the UNFCCC and UNDP for helping us fund this important effort.

I am confident that this long-awaited document will be an essential and authoritative source of information, even as we initiate work on our Third National Communication to the UNFCCC.

Thank you.

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Minister of Natural Resources and Environment, Malaysia

EXECUTIVE SUMMARY

Introduction

The Second National Communication (NC2) of Malaysia to the United Nations Framework Convention on Climate Change (UNFCCC) is prepared to meet Malaysia's obligation as a signatory party of the UNFCCC where Parties have agreed to periodically prepare a report on national greenhouse gas (GHG) emissions and measures taken to address climate change. The NC2 is a Government of Malaysia output of the United Nations Development Programme-Global Environment Facility (UNDP-GEF) Project on *Enabling Activities for the Preparation of Malaysia's Second National Communication to the UNFCCC* (NC2 Project). The project process has also helped Malaysia identify and widen the national climate change experts base, build capacity and fostered better working relationships between multi-sectoral stakeholders.

The NC2 process was conducted under the stewardship of the Ministry of Natural Resources and Environment (NRE) which chaired both the Project Management Group and the Project Steering Committee, assisted by a secretariat established under the project. Three thematic working groups established under the NC2 project provided the main contents of this report.

The NC2 contains an update of national circumstances up to 2007 in Chapter 1, followed by the national GHG inventory in Chapter 2. Based on the key sources identified in the inventory, the report then presents mitigation measures and their resulting potential contribution to emissions reduction in Chapter 3. Chapter 4 examines the vulnerabilities to the impacts of climate change in several key sectors and proposes adaptation measures. Chapter 5 provides an update from the Initial National Communication (INC) on Research, Technology Transfer and Systematic Observation while Chapter 6 outlines developments in terms of capacity building and general public awareness. In noting the advances made in this NC, it is also important to recognise its limitations. Chapter 7 describes constraints as identified by the teams in undertaking their analysis and recommendations to overcome them. Finally, Chapter 8 discusses various strategies to address climate change. This includes initiatives that have been implemented since 2007, as well as proposed measures to strengthen the nation's resilience to climate change.

1. National Circumstances

This chapter provides background to the rest of the NC2 and updates information from the INC published in 2000.

Malaysia, located in South East Asia, comprises Peninsular Malaysia and the states of Sabah and Sarawak along with the Federal Territory of Labuan on the island of Borneo. The total area is 329,750 km^2 and contains a varied topography ranging from coastal areas to mountainous regions. Malaysia is bounded over by a coastline of 4800km.

The climate is tropical with mean daily temperatures of between 26°C to 28°C. Two monsoon periods occur between November–March and May–September. Rainfall is abundant, averaging 2,000mm to 4,000mm annually. Clouds cut off a substantial amount of direct sunlight in the afternoon and evening. Malaysia receives about 6 hours of direct sunlight daily.

Malaysia's forests are very rich in species and are extremely complex ecosystems. In 2000, 56% of total land area was forested whilst in 2007, it was 55%. Malaysia is also considered one of the world's mega-diverse countries and ranked 12th in the world on the National Biodiversity Index.

Rainwater is the main source of water. Malaysia receives about 990 billion m^3 annually. Rivers and reservoirs provide 97% of the nation's water demands and forests play an important role as water catchment areas. The demand for water is increasing as the population grows and the country develops.

Total population was 23.5 million in 2000 and increased to 27.2 million in 2007 with increasing population density. Urbanisation rate is increasing and was 63% in 2005. With more than 50% of the population being within the 15-64 age bracket, the urbanisation rate is expected to continue to increase. Life expectancy at birth also showed an upward trend. This improvement can be attributed to the extensive network of health care services in Malaysia, mainly provided by the government. The goal of *Health for All* was achieved by 2000.

Malaysia is a developing country that requires further economic expansion to achieve planned developmental goals. Gross national income (GNI)/capita increased from RM13,939 in 2000 to RM17,773 in 2007 at 2000 constant prices. The average GDP growth rate for the same period was approximately 5.6%. GDP for 2000 was made up as follows: services (48%), manufacturing (30%), mining (10%), agriculture (8%) and construction (4%) reflecting the same trend as that of 2007. Unemployment rose to 3.2% in 2007 from 3% in 2000.

Energy is a key driver of the Malaysian economy. Increasingly, more recent policies have focused on reducing dependency on petroleum products and environmental considerations while ensuring supply at affordable costs. The main sources of commercial energy supply in 2000 were natural gas (45.4%) and crude oil (45.5%). These sources remained major ones in 2007. However, the share of coal and coke increased from 5.6% to 14% in these years and only 2.4% came from the non-fossil source of hydropower in 2007. In terms of demand in 2000, 40.6% was for transportation, 38.4% for industrial purposes and 13.0% for residential use. By 2007, energy demand for industrial purposes had exceeded that for transportation, with demand in all sectors showing an increase. With the introduction of the Fifth Fuel Policy, renewable energy (RE) is also recognised as a feasible option.

Use of land transportation has grown evidenced by the increase in roads and motor-vehicle registrations from 2000-2007. At the same time, use of urban public transportation has also grown with increased ridership on the light rail systems, monorail and commuter trains in the Klang Valley. Currently, only a 10% area of the capital city, Kuala Lumpur, is directly served or within the transit catchments of existing stations. In some parts of the country, especially in some regions in the state of Sarawak, river transportation is the main form. Rail transport ridership has not shown much change in this period. Air transport on the other hand recorded a significant increase both in terms of passenger embarkation and disembarkation.

Oil palm and rubber are important agricultural crops that provide income and employment. Sustainable practices have been introduced and include utilisation of idle agriculture land, optimisation and certification for palm oil. Rice is a staple crop, its production has increased despite a reduction in cultivated area between 2000 and 2007. Overall livestock population, landings of marine fish and aquaculture production also increased in this period.

Waste generation varies between urban and rural areas. About 50% of waste in landfills is food waste largely due to the fact that while other recyclable materials are extracted before entering disposal sites, recovery rates for food waste are negligible. Peninsular Malaysia which is more urbanized compared to Sabah and Sarawak generated 20,500 tonnes in 2007, whilst the latter generated 1,210 tonnes and 1,988 tonnes respectively.

The establishment of NRE in 2004 has enabled better institutional coordination to address climate change issues. The "precautionary principle" approach and the "no regrets" policy that are generally applied have also been adopted towards adaptation and mitigation action. Greater cooperation between government agencies, the private sector and non-governmental organisations have resulted in more effective initiatives to foster public awareness.

2. Greenhouse Gas (GHG) Inventory

The GHG inventory documents the anthropogenic emissions and removals for the year 2000 from five sectors: Energy; Industrial Processes; Agriculture; Land Use, Land Use Change and Forestry; and Waste. The Revised IPCC 1996 Guidelines were used in line with Decision 17/CP.8 of UNFCCC Conference of Parties (COP) 8. The three main GHGs considered are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). As these gases have different global warming potentials (GWP), they have been converted to equivalence in carbon dioxide emissions[1]. Data to prepare the inventory were acquired from national and international statistics and stakeholder inputs. Local emissions factors were applied where available and the IPCC's default values were used otherwise. Collected data were also used for further analysis.

Malaysia's GHG emission was 222.99 Mt CO_2 eq in 2000 and removal was 249.78 Mt CO_2 eq. The net emission after accounting for the removal was -26.79 Mt CO_2 eq. Hence, Malaysia was a net sink in 2000. Details are presented in the Table ES 1.

Table ES 1: GHG Inventory for 2000

Sector	Emissions (Mt CO_2 eq)	Sink (Mt CO_2 eq)
Energy	147.00	
Industrial Processes	14.13	
Agriculture	5.91	
LULUCF	29.59	-249.78
Waste	26.36	
Total	222.99	-249.78
Net Total (after subtracting sink)	-26.79	

Comparisons between the INC inventory for 1994 and the NC2 inventory for 2000 were undertaken. However it is recognized that the information gained from such comparisons are limited as the number of categories considered in most sectors have expanded and an improved methodology was applied in preparing this inventory. Both these factors

1 1 t CH_4 = 21 t CO_2 eq and 1 t N_2O = 310 t CO_2 eq.

will result in changes in total figures unrelated to any changes in actual emissions between the two years. A list of categories considered in both inventories has been prepared to highlight differences. Where possible, the INC inventory was recalculated using the Revised IPCC 1996 Guidelines to enable comparison of data using the same methodology.

The report analyses major sources of emissions of the three different GHGs. The highest proportion of anthropogenic GHG emissions was in the form of CO_2 (75.1%) for 2000. Energy industries were the leading emitter of CO_2 (35%), and landfills led in CH_4 emissions (47%) while agricultural soils led in the emissions of N_2O (60%).

In terms of carbon sequestration, permanent reserve forests made the highest contribution.

An analysis of GHG emissions against development indices showed that emissions per GDP and per capita were 0.62 t CO_2eq/thousand RM and 9.5 t CO_2eq/capita respectively in 2000. Emission time series analysis for all sectors except industrial processes has been prepared from 1990-2007[2]. Although not as detailed as the inventory for 2000 or the earlier 1994 inventory under the INC, nevertheless, the time series highlight emission trends in the different sectors. The trend in the energy sector follows the GDP trend underscoring the fact that growth was fossil energy driven. Emissions from the waste sector have been rising, while that from the LULUCF and Agriculture sectors have stabilized.

Emission estimations show that Malaysia became a net emitter by 2005 with net emissions for 2005 and 2007 being 38.7 Mt CO_2 eq and 45.9 Mt CO_2 eq respectively.

A key source analysis to rank the sources of emissions showed that the three highest sources belonged to the energy sector (energy industries, transport, and manufacturing industries and construction) followed by the waste sector (landfills) and the LULUCF sector (forest and grassland conversion). The cumulative total for these five sources alone came up to almost 76%. Fugitive emissions from oil and gas systems made up almost 10% of total emissions and cement production about 4%.

3. Mitigation Analysis

The mitigation analysis starts by identifying options for emissions reductions in the five sectors considered in preparing the GHG Inventory. Some of these options, that correspond with measures in the highest ranked emissions sources in the key source analysis, are considered in greater detail. This is done by examining the mitigation potential in existing initiatives or policies guiding Malaysia's development sustainably.

The mitigation assessments were prepared with reference to business-as-usual (BAU) baseline projections from 2000 until 2020, taking into account national economic and social policies, development trends and projections. The assessments then consider the emission reduction potential of certain interventions if successfully implemented. Apart from the emissions reduction potential, where possible, the assessment includes a cost analysis, identification of barriers to implementation, assessment of technology options for different mitigation proposals, institutional capacity-building needs to sustain mitigation work, and related legal and institutional frameworks. Preliminary cross-sectoral issues are also raised.

Based on the individual assessments, the potential contribution towards achieving

2 For the Agriculture sector, the time series is until 2005.

Malaysia's voluntary indicator of up to a 40% reduction in the GHG emissions intensity of GDP compared to 2005 values by 2020 as announced at the UNFCCC COP 15 in Copenhagen is assessed. This indicator is one of the measures of the nation's success in efforts to develop sustainably. Timely transfer of environmentally friendly and sound technologies and access to adequate financing under the UNFCCC will ensure that Malaysia meets this goal.

For the energy sector, BAU projections were compared to scenarios which incorporated RE and energy efficiency (EE) measures. The RE assumption is based on goals indicated in policy documents while the EE assumption was derived from findings of audits under the Malaysian Industrial Energy Efficiency Improvement Programme (MIEEIP). BAU is expected to have produced 259.8 Mt CO_2 while the successful implementation of both the RE and EE measures is expected to reduce emissions to 234.1 Mt CO_2 by 2020.

Malaysia's Rio 1992 pledge of maintaining 50% land area as perpetual forest cover was reiterated in Copenhagen in 2009. The LULUCF analysis starts by noting that BAU would result in forest cover being precariously close to this minimum by 2020. It then develops a methodology to compare costs involved in the two broad mitigation approaches described: reducing the rate of forest conversion and increasing sequestration through establishing new forest plantations. A 1% and 5% reduction in deforestation rate can reduce about 3.34 Mt and 16.68 Mt of CO_2 eq respectively from now until 2020, while a low 50,000 ha/yr rate of forest establishment could sequester about 29 Mt. Using historical data and assumptions on carbon price, forest carbon density and opportunity cost[3], calculations show that the first approach is more economical than the second. However, in both instances, the lost earnings is greater than the benefit calculated in terms of earnings for carbon stocks. While this shows that forest carbon prices need to be higher to be competitive, valuation for other benefits or ecosystem services such as community livelihoods, biodiversity, water supply at least should be included for a more accurate comparison in future analysis.

Waste sector mitigation measures that have been assessed further in this report pertain to landfill solid waste management. Comparisons have been made between the projected emissions under the BAU scenario and those assuming an increased recycling rate of 22% and the successful introduction of alternative technologies such as material recovery facilities and thermal treatment plants to reduce organic waste content in landfills. These measures have been assumed from the national policies on waste management for Peninsular Malaysia. Along with these measures, emissions projections have been made assuming landfill methane recovery rate of 25%. BAU expects emissions in the region of 42.8 Mt CO_2 eq, while with the successful implementation of these measures, emissions could be reduced by almost 58% to 18.1Mt CO_2 eq.

For the Agriculture sector, measures to reduce emissions through irrigated rice water management, nitrogen fertiliser management and manure management have been described. CH_4 which is produced in continuously flooded rice fields can be substantially reduced with more precise water management; nitrogenous fertilisers that release N_2O can be replaced with natural sources such as bio-fertilisers or soil microbes; and manure management can reduce CH_4 emissions, produce bio-fertilisers and facilitate the capture of biogas to serve as an energy source.

For Industrial Processes, the mitigation proposal pertains to cement manufacture based on the findings in a Clean Development Mechanism (CDM) project. Decreasing clinker in cement production by using additives or changing clinker composition to non-carbonated calcium sources has been shown to reduce emission by about 10%. This proposal should

3 The alternative land use in both cases is assumed to be conversion to or establishment of oil palm plantations. The opportunity cost is assumed to be the loss of potential earnings in not doing so.

be explored further in terms of feasibility in cement production as a whole.

A preliminary cross sectoral analysis has been attempted to identify ensuing impacts on other sectors of mitigation measures in one sector. It serves to highlight the need to take a holistic approach in considering mitigation options and underscores proper planning to harness maximum benefits from mitigation measures. For example, sources of RE can come from all the other sectors. Optimised use of these sources should be considered however before decisions are made towards channelling them towards RE generation.

With regard to meeting the scenario of reducing GHG emissions intensity, the measures considered above, if successfully implemented, would make substantial contributions. An in-depth study, especially on the cost benefit aspect, continuous monitoring and other initiatives specifically in key areas like transportation are necessary to achieve this indicator.

4. Vulnerability and Adaptation (V&A) Assessments

The NC2 V&A assessment updates the INC assessment in identifying potential impacts across seven sectors: Water Resources, Agriculture, Biodiversity, Forestry, Coastal and Marine Resources, Energy, and Public Health.

The assessments are conducted using future climate projections from two downscaled models: The "Regional Hydro-Climate Model for Peninsular Malaysia" (RegHCM-PM), a dynamic downscaled model at 9 km resolution; and the "Providing Regional Climates for Impacts Studies" (PRECIS) downscaled to 50 km resolution for Malaysia. The former makes climate projections until 2050 whilst the latter goes up to 2099.

Table ES 2 outlines observed and projected climatic changes. The projections are based on the medium range emission scenario.

Table ES 2: Observed and Projected Climate Change

	Observed	Projected (by 2050)
Temperature	0.6-1.2 °C per 50 years (1969-2009)	• 1.5-2 °C increase
Rainfall (amount)	no appreciable difference	• (-) 5% to (+) 9% change in regions within PM • (-) 6% to (+) 11% change in regions within Sabah and Sarawak
Rainfall Intensity	Increased by 17% for 1 hour duration and 29% for 3 hour duration (2000-2007 compared to1971-1980)	• Increase in extremes within wet cycles • Increase in frequency of extreme weather
Sea Level Rise (SLR)	1.3 mm/yr (1986-2006, Tanjung Piai, Johor)	• 0.5m rise (Global high worst case at 10mm/yr)

Based on the projections above, each sector conducted impact assessments. Some of these impacts related to water such as consumption and irrigation shortages. Floods, land erosion, reduced crop yields especially for economically important ones such as oil palm, rubber and paddy, encroachment on sensitive habitats with resulting impacts on biodiversity, coral bleaching, damage to infrastructure, impacts on equipment efficiency, and increased transmission of diseases like dengue, malaria and cholera are other impacts that have been identified.

Several adaptation measures have been proposed for consideration in the report. These include "no-regrets" actions and those recommended specifically to address projected climate change impacts. Implementing the "no-regrets" actions such as improved water resources management will prove useful regardless of whether future climate change impacts do indeed occur. Further in-depth studies and analysis however are necessary before some of the major actions specifically addressing projected climate change impacts are implemented. This is to account for the uncertainties surrounding future climate projections. While Malaysia has made advances in V&A analysis through the downscaling of two climate models, given the general uncertainties surrounding model projections presently, more such efforts are required to increase confidence levels. Nevertheless, the projections serve an important purpose by honing in on specific areas in which future research and assessment activities can be focused.

5. Research, Technology Transfer and Systematic Observation

Climate change research in Malaysia since the INC include developing two models for downscaling future projections as mentioned in section 4. Pilot studies for the National Coastal Vulnerability Index (NCVI) have been completed taking into account physical, biological and socio-economic parameters. This is expected to be a useful planning tool in addressing impacts of climate change on coastal areas such as SLR, wave action erosion and extreme weather. Research on forests and sequestration rates have provided a more comprehensive understanding of the services provided in the carbon cycle as well as carbon dioxide flux. Examples of research in RE include the construction of the Green Energy Office or GEO Building as a prototype of a building using renewable technology that is feasible in Malaysia. Research on oil palm shows that the biofuel yield per ha of oil palm is far superior to that of other traditional staple oils crops like soy bean, sunflower and rape seed at seven times the average yield of these other crops. Research on the co-relationship between climate factors and health issues like the transmission of malaria and dengue has provided a better understanding of the threats climate change pose to human health.

The main avenue for technology transfer pertaining to climate change is through CDM projects. Technology transfer benefits or improvement of existing technology is one of the criteria for CDM projects approval at the domestic stage. Proposed CDM projects therefore should demonstrate measureable impacts on indigenous capacity to apply, develop and implement environmentally sound technologies.

Systematic observations in the country to collect data and information on climate change are mainly through a network of climate and hydrological monitoring stations. The Malaysian Meteorological Department (MMD) also operates a Global Atmospheric Watch (GAW) station at Danum Valley, Sabah and two regional GAW stations, i.e. at Petaling Jaya, Selangor and Cameron Highlands, Pahang as part of the World Meteorological Organisation (WMO)'s GAW programme. In terms of public health, continuous surveillance data for selected communicable diseases is available in light of the reporting requirement mandated under the Prevention and Control of Infectious Diseases Act 1988. Malaysia's energy data is annually recorded in the National Energy Balance. The introduction of the Malaysia Energy Database and Information System

(MEDIS) has facilitated this through the online submission of data.

6. Capacity Building, Education, Public Awareness, Information and Networking

Several initiatives have been undertaken to enhance the nation's capacity in dealing with climate change. Also, an increasing number of activities to educate the public on the myriad issues concerning climate change have been observed and overall public awareness of the issue can be said to have increased. New media using the internet has been instrumental in information sharing and networking especially amongst youth.

Capacity building in Malaysia has mainly been through climate change related projects which have generated local data and information, an appreciation for the multi-sectoral aspects of climate change analysis and improvement of skills to address climate change challenges. Examples of these projects include the Climate Change Modelling Capacity Building Project using the PRECIS model by the Hadley Centre, UK; the development of RegHCM-PM; the Multilateral Environmental Agreement (MEA) project in collaboration with Danida; the Workshop on Greenhouse Gas Inventories in Asia (WGIA) with the Japanese government; and the Agriculture Land Use (ALU) model training programme for South East Asia by the UNFCCC and USEPA. The NC2 project has also enabled capacity building through participation in regional and domestic workshops as well as hands on involvement in preparing this report. A review by external experts of the application of the recommended guidelines in preparing the GHG Inventory has raised domestic confidence in this activity. CDM capacity building activities have also been organised by the Designated National Authority (DNA) and the respective technical secretariats. Hosting regional conferences and workshops in Malaysia has provided exposure to a wider pool of local experts and fostered exchanges with counterparts from other countries.

Efforts to educate Malaysians on the issues of environment and sustainable living in general and climate change specifically have been ongoing. Institutions of higher education now present students with a wider range of courses relating to these subjects. Initiatives like the *Suria 1000* project to promote and educate the public on the use of solar power; energy star rating for some electrical goods; and the Green Building Index (GBI) catering for local circumstances enable the public to make informed choices. Numerous seminars and conferences have helped disseminate information on international climate negotiations, emerging climate change issues such as Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD), extreme weather and broader concepts like the ecological footprint. Competitions too have served the purpose of educating the public through the implicit need of gaining knowledge on climate change, the environment or sustainable living in order to participate. In general, these efforts are either undertaken by specific government entities, NGOs, the private sector, or collaboratively.

Public awareness while having generally increased is however not very apparent from changed behavioural patterns. Indications of improved awareness include companies voluntarily adopting sustainable practices, initiatives by university students and some local councils to be green, and increased newspaper coverage of such efforts, reflecting that readerships do care about these issues. Nevertheless, ongoing efforts will have to be further strengthened. These ongoing efforts include top down measures by the government such as tax incentives and a green technology fund complemented by bottom up initiatives. NGO involvement in enhancing public awareness range from outreach activities through seminars and projects, such as the Mobilising Malaysians on Climate Change project, to organising Green Hunts using public transportation and *Hari Organik* (Organic Day) events that promote organic produce and farming practices in a festive environment. The *Voluntary Carbon Offset Scheme* (VCOS) is an example of a partnership between the public and private sectors to enhance public awareness on individual emissions and enabling voluntary action to account for it. Public recognition through awards like the Prime Minister's Hibiscus Award, Langkawi Environment Award and Merdeka Award for contributions to the environment has also heightened awareness of its importance.

Information sharing and networking has improved especially with greater application of ICT. Malaysia through NAHRIM is the Regional Water Knowledge Hub for Water and Climate Change Adaptation in South East Asia under the Asia Pacific Water Forum. The formation of the Malaysian Environmental NGOs (MENGO) has increased coordinated and cohesive contributions by civil society and enabled more effective engagements. Youth networks have also been formed to mobilise activism and initiatives by young people concerned about climate change and the environment generally.

7. Constraints and Needs

The National Capacity Self Assessment (NCSA) Project in assessing Malaysia's ability to implement MEAs identified general needs in addressing climate change. These include better coordination amongst ministries and agencies given the multi-sectoral nature of climate change issues; dedicated research programmes and funding to address climate change; comprehensive monitoring of actions taken to ensure their effectiveness; improving negotiation capacity, strengthening the policy, institutional and legal framework; and mainstreaming awareness and public participation.

Constraints were also encountered by the three thematic working groups in preparing the inputs for this NC, resulting in some gaps in the analysis. These are highlighted to enable action to be taken to address them in future efforts. Common constraints include lack of data, technical ability, financing and technology. Access to appropriate technology accompanied by capacity enhancement is also generally lacking. The major barrier is the significant upfront investment required as most technologies are protected by patents or licences.

8. Addressing Climate Change

Measures in 17 areas have been identified to provide greater coherence in actions to address climate change in Malaysia. Some are proposals, whilst others have already been initiated since 2007.

The first two pertain to promoting information sharing and access to data. Enhancing and developing National Climate Services in line with the Global Framework for Climate Services and effective coordination of the national Global Climate Observation Systems (GCOS) are proposed.

Many climate change impacts in Malaysia are expected to be related to water. "No-regrets" options like implementing IWRM, IRBM and improved demand side management by reducing non-revenue water, and implementing measures like rainwater harvesting can commence immediately. Design specifications for water management infrastructure such as drainage and dams should be reviewed in light of climate change projections.

For coastal areas, a systematic programme supported by appropriate legislation for the effective nationwide implementation of ISMP should be formulated. Extending the NCVI throughout Malaysia can augment ISMP implementation.

Diseases like malaria which are almost eradicated could re-emerge with climate change.

Mapping the mosquito vector using remote sensing technology should be explored for enhanced surveillance and control in the event of an outbreak. Aedes-proofing buildings and infrastructure to limit breeding grounds can reduce the spread of dengue. Capacity to conduct vulnerability assessments must be built right down to the district levels to enable effective monitoring. Mathematical modelling should be a health research priority with mathematician research officers being hired by MOH and through collaboration with academic institutions.

Green and low carbon cities and townships and developing sustainable regions will ensure greater resilience towards negative climate change impacts. The plans for the nation's economic growth regions should be revisited to incorporate climate change concerns.

Climate change threatens food security. Competition for limited water resources is expected in times of drought. Precision water management and drainage in the main granary areas will not only ensure sufficient water availability for both agriculture and other uses in times of drought, but also reduce GHG emissions arising from continuous flooded cultivation practices. Traditional practices should also be revisited as they may provide adequate localised solutions. Practices like using compost and applying microbial bio-fertilisers will reduce reliance on synthetic nitrogenous fertilisers that release GHGs with high GWPs.

In terms of energy, strategies have been formulated to promote RE to overcome the initial barriers encountered. A Feed-in Tariff Mechanism, the cornerstone of the RE Policy and Action Plan, has been proposed to spur RE development. EE&C measures to promote the rational use of energy and move towards a low-carbon, high-income economy is to be driven by the National EE Masterplan which is under development. While pursuing these "no-regrets" options, Malaysia is also considering other options like nuclear energy, the feasibility of which requires detailed and comprehensive studies.

A welcome development which will certainly help in controlling emissions from a key sector, transportation, is the heightened focus on improving public transportation which has been identified as one of the current Government's National Key Results Area (NKRA). Two Acts, the Public Land Transport Commission Act 2010 and the Land Public Transport Act 2010 have been passed and a Public Land Transport Commission established.

Improving industrial processes will reduce emissions from industries. Strategically, high-energy intensive industries and those with increasing energy intensity ratios should be targeted first for improvements. A roadmap to guide the transformation to more sustainable processes in the long run should be formulated.

Forests play an important role in both adaptation and mitigation from soil and water protection, conservation of biological diversity and regulation of the climate system to carbon sequestration. Malaysia has pledged to keep at least 50% as forested areas. This was reiterated by the Prime Minister during COP 15 in 2009. Strategies towards this include sustainable forest management practices, establishing forest plantations on marginal/ unproductive land to ease logging pressures elsewhere along with enrichment and replanting in logged over or poor forests. A nation-wide initiative to plant 26 million trees, or one tree per Malaysian, by 2015, was launched by NRE in 2010. In addition, the National Landscape Department is to plant 20 million trees in urban areas from 1997-2020 to green cities.

Waste management strategies should be enhanced to include measures to encourage recycling of organic and green waste to reduce the amount of such materials in landfills and the consequent emission of GHGs. The compost produced can be used for agriculture.

R&D and technology transfer especially through CDM projects under the UNFCCC Kyoto Protocol provide avenues for Malaysia to develop sustainably. The Prime Minister highlighted the critical importance of technology transfer when he noted that Malaysia's success in meeting the 2020 voluntary emissions intensity reduction scenario is conditional upon adequate access to technology. New areas such as biofuels, clean coal, carbon capture and storage as well as low-tech solutions such as green and white roofs should be considered. At the same time, traditional knowledge and methods should be collated as they form time tested responses to challenges posed by the environment we occupy. Efforts to ensure the continuation of the Kyoto Protocol into its second and future commitment periods should be enhanced as investments to build CDM capacity have been made. Additionally, CDM is the main channel for technology transfer to address climate change in Malaysia.

Two recent policies, the National Policy on Climate Change and the National Green Technology Policy, were formulated to collectively guide the nation towards addressing climate change holistically, ensuring climate-resilient development, developing a low carbon economy and promoting green technology. They are important in achieving Malaysia's broader development goals of sustainably achieving a high income nation status. A key indicator to measure Malaysia's success in this is the voluntary reduction of emissions intensity of GDP by up to 40% of 2005 levels by 2020. A National Green Technology and Climate Change Council, chaired by the Rt. Hon. Prime Minister, was established in early 2010 to enable strategic implementation of these policies and foster greater coordination in these complementary areas.

The final measure is to enhance public awareness and participation. To supplement ongoing efforts, newer modes of outreach offered by IT such as blogs and Facebook should be explored. Collaboration with the arts community can creatively educate the public using visual and performing arts. This can change public perception and act as a more effective change catalyst than incentives or threats.

In conclusion, the success of these measures is dependent on a mixture of internal and external factors. An important driver of the climate change agenda in the country is the announcement of voluntary reduction of emissions intensity of GDP by 2020. The recognition of sustainability as one of the three pillars of the New Economic Model announced in 2010 can be regarded as another. Timely and adequate access to technology, financial resources and acquiring enhanced capacity is critical. Developed countries should honour their obligation to provide these. Equally, developed countries should hasten to take sufficiently strong domestic emission reduction targets. Malaysia therefore has to be poised to secure both these important elements of internal and external factors to progress on a sustainable growth path while developing in a carbon constrained world.

Introduction

Malaysia became a Non-Annex I Party to the United Nations Framework Convention on Climate Change (UNFCCC) when it ratified the UNFCCC in 1994. Malaysia ratified the Kyoto Protocol in 2002.

This report was funded by the United Nations Development Programme-Global Environment Facility (UNDP-GEF) Project on Enabling Activities for the Preparation of Malaysia's Second National Communication to the UNFCCC ("NC2 Project"). The activities within the NC2 Project are a continuation and upgrade of the work done under the Initial National Communication which was submitted in 2000. The main components are: a) The National Inventory of Greenhouse Gases (GHGs) b) Analysis of Potential Measures to Mitigate GHG Emissions; and c) Assessment of Potential Impacts of Climate Change, Vulnerabilities and Potential Measures to Adapt. The process of implementing the project has enhanced national capacities and raised general knowledge on climate change. The project structure required hands-on involvement from a wide pool of stakeholders representing a broad range of government agencies, research institutions, the private sector, NGOs and academic institutions. Numerous meetings and workshops to consult stakeholders were held by the appointed lead or chairing agencies for each of the three thematic areas mentioned above as well as their respective sub-sectors. This process whilst admittedly time consuming, nevertheless proved useful in gaining information and inputs from a wide pool of stakeholders. At the same time, it also increased the participating stakeholder's knowledge on climate change issues facing the country in a more holistic manner given the multi-sectoral nature of these interactions.

Hence apart from the completion of the main mandate of the project, the preparation of this report, the NC2 Project process has also helped generate wider interest in the climate change challenge and established a readily identifiable source of national experts. The overall project budget was USD 405,000 from GEF. In-kind government contribution was originally estimated at USD 60,000 in terms of providing office space, administrative guidance and support as well as other related contributions. However the government contribution in actual fact is far greater given the hands-on involvement in terms of man hours and expertise for the various thematic area report preparations and related activities, travel costs, as well as undertaking some of the studies that provided inputs to the analysis in this report.

In addition to this, there were several other activities sponsored partially or fully by either the National Communications Support Programme (NCSP), the UNFCCC or donor countries that further contributed to the capacity building achieved by the project. These include reviews by international experts of the application of the Intergovernmental Panel on Climate Change (IPCC) 1996 Guidelines by local experts in preparing the national GHG inventory, regional workshops on Long range Energy Alternative Planning (LEAP) modelling for the Energy sector and guidance on conducting Vulnerability and Adaptation assessments.

Stakeholders of the project also benefited from capacity building for future inventory work to enhance capacities to advance to a combined inventory for the Agriculture and Land Use, Land Use Change and Forestry sectors through participation in the regional project on the application of the Agriculture Land Use (ALU) software.

The NC2 starts with a description of national circumstances up to 2007 in Chapter 1, followed by the national GHG inventory in Chapter 2. Based on the key sources identified in the inventory, the report then presents mitigation measures and their resulting potential contribution to emissions reduction in the country in Chapter 3. Thereafter Chapter 4 examines the vulnerabilities to the impacts of climate change in several key sectors and proposes adaptation measures to reduce the severity of these impacts. Chapter 5 provides an update from the Initial National Communication (INC) on Research, Technology Transfer and Systematic Observation while Chapter 6 outlines developments in terms of capacity building and general public awareness. In noting the advances made in this national communication, it is also important to recognise that there are limitations which need to be overcome in future efforts. Hence Chapter 7 describes constraints as identified by the teams in undertaking their analysis and recommendations to overcome them. Finally, Chapter 8 discusses various measures and activities to address climate change. This includes initiatives that have been implemented since 2007, as well as proposed measures to strengthen the nation's resilience to climate change.

This report is the culmination of work undertaken by the various thematic groups comprising the Thematic Chairs, Sub-Sector Chairs and their respective stakeholders. The process has been guided by the Project Management Group and Project Steering Committee, both chaired by the Ministry of Natural Resources and Environment (NRE), assisted by a secretariat established under the project. Appendix 1 shows the organisational framework that was adopted in preparing the NC2.

Chapter 1

NATIONAL CIRCUMSTANCES

CHAPTER 1:
NATIONAL CIRCUMSTANCES

This chapter updates information on national circumstances contained in the Initial National Communication (INC) up to the year 2007. The data provided was used in the assessments contained in the rest of this report. A summary of Key Data is provided in Appendix 2.

1.1 Geography: Location & Topography

Malaysia, located in South East Asia, lies between 1ºN and 7ºN of the equator, and 99.5ºE and 120ºE. It covers an area of approximately 329,750 km^2, consisting of Peninsular Malaysia; the states of Sabah and Sarawak; and the Federal Territory of Labuan in the north western coastal area of Borneo Island. The two regions are separated by the South China Sea. Eleven states and two federal territories (Kuala Lumpur and Putrajaya) are located in Peninsular Malaysia.

The topography of Peninsular Malaysia is variable, ranging from coastal areas to mountainous regions. The peninsula is dominated by a central mountainous spine extending from north to south, known as the Titiwangsa Range, extending about 480km in length and 900-2100m in height above sea level.

The topography of Sabah is mountainous, especially in the west coast, with undulating lowland basins in the eastern part. The Crocker Range divides the western coastal plains from the rest of Sabah on the south of Mount Kinabalu, which is the highest mountain in Malaysia at 4101m above sea level.

Sarawak's topography shows a flat coastal plain followed by a narrow belt of hills with a sharp rise of mountainous mass extending the full length of the state. Mount Murud is the highest peak at 2423m, followed by Mount Mulu. Mount Mulu has the largest natural limestone cave system in the world.

Malaysia is also bounded by over 4800km of coastline. The weather along these coastlines is influenced by convective rain and the distribution of rainfall is greatly influenced by topography and the monsoon winds.

1.2 Climate

Malaysia experiences relatively uniform temperatures throughout the year with the temperature in the lowlands ranging between 21°C at night and 32°C during the day. The daily mean temperature is between 26°C and 28°C.

The wind over the country is generally light and variable. There are, however, some uniform periodic changes in the wind flow patterns. Northeasterly winds prevail during the boreal winter monsoon (locally known as the northeast monsoon) from November to March. The southwesterly winds prevail during the boreal summer monsoon (locally known as the southwest monsoon) from May to September. These monsoons are separated by two shorter inter-monsoon periods.

Malaysia receives abundant rainfall with average annual rainfall ranging from about 2,000mm to 4,000mm. The east coast of Peninsular Malaysia, northeast of Sabah and southern Sarawak receive spells of heavy monsoon rainfall lasting from 1 to 3 days during the northeast monsoon and sometimes causing severe floods. The boreal summer monsoon is relatively drier. The inter-monsoon periods generally received heavy rainfall from convective showers and thunderstorms in the late afternoon and evening.

Clouds cut off a substantial amount of direct sunlight in the afternoon and evening and Malaysia receives about 6 hours of direct sunlight per day.

1.3 Forests and Land Use

The forest ecosystem plays a major role in the global carbon cycle. Forests are also important for water regulation and flood management in river basins. They are also a source of timber products, income for the rural population as well as home to local ethnic peoples.

Malaysian forests are very rich in species and are extremely complex ecosystems. In 2000, approximately 56 percent of the total land area of Malaysia was still forested. This included permanent reserve forests (PRFs), state land forests, national parks, as well as wildlife and bird sanctuaries. The remaining comprised of areas of agricultural crops, rubber plantations, oil palm plantations, urban or other uses. In 2007, 18.30 million ha, or approximately 55 percent of the total land area of Malaysia was still forested. Table 1.1 presents a breakdown of the total forested area in Malaysia.

Table 1.1
Malaysia: Total Forested Area

Region	**2000** (million ha)	**2005** (million ha)	**2007** (million ha)
Peninsular Malaysia	5.94	5.87	5.87
Sabah	4.42	4.36	4.36
Sarawak	8.20	8.07	8.07
Total	18.56	18.30	18.30

Source: Ministry of Plantation Industries and Commodities, 2008[4]

Some of the national and state parks in Malaysia have been designated as United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Sites (Natural List), Association of Southeast Asian Nations (ASEAN) Heritage Sites, and Ramsar Sites (see Tables 1.2 and 1.3).

Table 1.2
Malaysia: World Heritage Sites

Parks	**UNESCO World Heritage Site** (Natural)	**ASEAN Heritage Site**
Kinabalu Park	√ (2000)	√
Gunung Mulu National Park	√ (2000)	√
Taman Negara National Park		√

Source: Ministry of Natural Resources and Environment (NRE) (2009)[5]

4 Statistics on Commodities

5 4th National Report to the Convention on Biological Diversity

Table 1.3
Malaysia: Ramsar Sites

Name	Date	Area (ha)
Tasek Bera, Pahang	10/11/94	31,120
Tanjung Piai, Johor	31/01/03	526
Pulau Kukup, Johor	31/01/03	647
Sungai Pulai, Johor	31/01/03	9,126
Kuching Wetlands, Sarawak	08/11/05	6,610
Lower Kinabatangan - Segama Wetlands, Sabah	28/10/08	78,803

Source: NRE 2009

1.4 Biodiversity

Malaysia is considered as one of the world's mega-diverse countries[6] and ranked 12th in the world according to the National Biodiversity Index. The index is based on the estimates of country richness and endemism in four terrestrial vertebrate classes and vascular plants[7].

Malaysia has an estimated 15,000 species of vascular plants, 229 species of mammals, 742 species of birds, 242 species of amphibians, 567 species of reptiles, over 290 species of freshwater fish, and over 500 species of marine fish.

The terrestrial biodiversity of Malaysia is concentrated in the tropical rainforests that extend from coastal plains to mountain areas, including inland waters such as lakes and rivers. Marine biodiversity is found among island, marine and coastal ecosystems such as coral reefs and sea grasses. Table 1.4 presents an overview of ecosystems in Malaysia.

Biodiversity resources offer economic benefits, food security, environmental stability as well as scientific, educational and

6 http://www.cbd.int (viewed March 2009)

7 Forest Research Institute of Malaysia (FRIM) and UNDP Malaysia. (2008). Natural History Museum Malaysia: Planning and Development.

Table 1.4
Overview of Ecosystems

Thematic Area	Ecosystem
Forest Biodiversity	Lowland evergreen forest Lowland dipterocarp forest Heath forest Limestone forest Mixed dipterocarp forest Hill dipterocarp forest Hill mixed dipterocarp forest
Mountain Biodiversity	Montane forest Subalpine forest
Inland Waters Biodiversity	Peat swamp forest Freshwater swamp forest Riparian forest Rivers, ponds, lakes, etc. Mangrove forest
Marine and Coastal Biodiversity	Coastal hill dipterocarp forest Mangrove forests
Islands Biodiversity (please refer to Forest Biodiversity for non-marine and non-coastal related ecosystems)	Mudflats Coral reef Sea grass
Agricultural Biodiversity	Plantations Rice fields Fruit orchards & vegetable farms Livestock rearing and aquaculture farms

Source: NRE 2009

recreational values. Biodiversity provides direct economic benefits through timber and non timber produce; food and industrial crops. It also offers the potential source of materials for biotechnology that could lead to livestock and crop improvement, and development of pharmaceutical products. The diversity of plants and animals including fish offers a diverse gene pool to ensure food security. Biodiversity also enables the provision of myriad ecological services which ensure environmental stability. These services are crucial for the improvement of air and water quality, maintenance of hydrological regimes, soil formation, soil and watershed protection, recycling of nutrients, energy supply, carbon sequestration and oxygen generation.

1.5 Water Resources

Malaysia's economic growth and sustainability could be attributed to its relatively abundant annual rainfall, timely planning and implementation of water resources development and management projects.

Unlike other countries that rely on glaciers or very large and continuously flowing rivers, Malaysia's water resources are mainly dependent on rainfall. Most of its agriculture, all the lush forests and rich biodiversity are rain-fed. Based on the National Water Resources Study (1982), the country receives about 990 billion cubic metres of water from rainfall annually. From this, 566 billion cubic metres flows overland as surface runoff, 360 billion cubic metres returns to the atmosphere through evapotranspiration and 64 billion cubic metres percolate to groundwater.

Rivers and reservoirs provide 97 percent of the nation's water demands. The role of forests as water catchment areas is therefore vital in ensuring a sustainable source of water. Except for relatively large rivers such as the Rajang, Kinabatangan, Pahang, Kelantan, Terengganu and Perak Rivers, others are short rivers with small catchment areas. These features render some river basins in the low-lying and coastal areas prone to flood as the result of high intensity and/or long duration rainfall. These characteristics also expose certain regions to water stress and droughts.

As the country grows, demand for water increases. In order to ensure adequate and stable supply during dry periods, dams and reservoirs need to be constructed. Inter-basin water transfer projects are being implemented to supply water to areas that are experiencing high economic development and growth.

1.6 Population

1.6.1 Population and Density

The total population of Malaysia in 2000 was 23.5 million. Population increased approximately 12 percent over the period 2000-2005. The increase of population from 1990 to 2000 was about 30 percent.

The population of Malaysia in year 2007 was 27.2 million. The total population of Malaysia in 2005 was 26.4 million. From year 2005 to 2006, and 2006 to 2007, the annual increase was about 1.9 percent and 1.1 percent respectively.

The population density of Malaysia increased from 55 / km^2 in year 1990 to 71 / km^2 in year 2000. By 2007, the population density was 82 / km^2.

1.6.2 Urbanisation Rate

The urbanisation rate of Malaysia in 2000 was 62 percent. It is estimated that by 2010 the rate would be 63.8 percent. Urbanisation rate varies from state to state. Table 1.6 presents the urbanisation rate of the states in Malaysia in 2000 and 2005.

Table 1.6
Malaysia: Urbanisation Rate by State

State	2000	2005
Kedah	39.1	39.8
Perak	59.1	59.3
Perlis	34.0	35.1
Pulau Pinang	79.7	79.8
Melaka	67.5	70.6
Negeri Sembilan	54.9	56.3
Selangor*	87.7	88.4
Federal Territory of Kuala Lumpur	100.0	100.0
Federal Territory of Labuan	76.3	77.6
Johor	64.8	66.5
Kelantan	33.5	33.4
Pahang	42.0	43.5
Terengganu	49.4	49.8
Sabah	48.1	49.8
Sarawak	48.1	49.5
Malaysia	62.0	63.0

* includes Federal Territory of Putrajaya
Source: EPU (2006)[9].

Table 1.5
Population Density of Malaysia

Year	1990	2000	2005	2006	2007
Population (million) mid-year	18.1	23.5	26.4	26.9	27.2
Population Density (population / km^2)	55	71	80	81	82

Source: Economic Planning Unit (EPU)[8]

8 http://www.epu.gov.my (viewed June 2010)

9 Ninth Malaysia Plan (2006-2010)

1.6.3 Age Distribution

In 2000, approximately 34 percent of the population was under 15 years old, 62 percent was from between ages 15–64, and only 4 percent was over 65 years of age. The same trend is observed for 2007. Urbanisation rate is expected to increase.

Table 1.7
Malaysia: Population by Age Groups

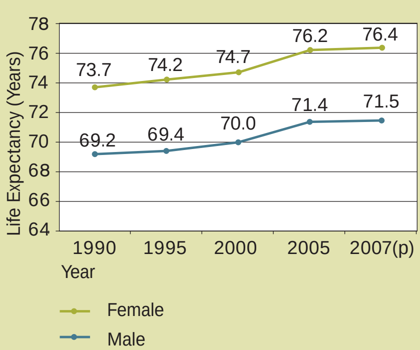
Age Group \ Year	2000	2005	2007
Less than 15	34.1%	29.6%	28.5%
15 to 64	62.0%	66.2%	67.1%
65 and above	4.0%	4.2%	4.3%
Total	100%	100%	100%

Source: EPU Website

1.6.4 Life Expectancy

The average life expectancy at birth shows an upward trend. Female life expectancy increased from 74.7 years in 2000 to 76.4 years in 2007. Male life expectancy increased from 70.0 years in 2000 to 71.5 years in 2007. Please refer to Figure 1.1.

Figure 1.1
Malaysia: Life Expectancy at Birth



Notes: (p) provisional

Sources: Department of Statistics (DOS) Demographics 2008[10] and 2009[11]

10 Demographic Indicators Malaysia 2008

11 Demographic Indicators Malaysia 2009

1.6.5 Public Health

The Ministry of Health (MOH) is the lead agency and the main provider of health care services in Malaysia. Primary health care services are delivered through an extensive network of government health facilities (802 health clinics, 1927 community clinics, 95 maternal and child health (MCH) clinics, 193 mobile health clinics, 2200 dental clinics) as well as 6371 private medical clinics and 1435 private dental clinics. This primary health care network is supported by secondary and tertiary services provided by the government (130 MOH hospitals, six MOH medical institutions, seven non-MOH hospitals) and private facilities (209 hospitals, 22 maternity homes, 12 nursing homes, three hospices)[12].

The goal of Health for All for Malaysia was achieved by 2000 and the country is well-positioned to achieve the Millennium Development Goals. Selected mortality indicators have shown marked reductions. However, climate change has the potential to affect national health.

1.7 Economy

1.7.1 Gross Domestic Product (GDP)

The GDP of Malaysia has shown an upward trend from 2000-2007. The average growth rate for GDP at constant prices from 2000-2007 is approximately 5.6 percent. In terms of per capita growth, the GDP per capita grew from RM15,169 in year 2000 to RM18,633 in year 2007. Table 1.8 shows key data on GDP and gross national income (GNI).

The main contributions to GDP for year 2000 were from the services sector (48%) and manufacturing sector (30%), followed by mining (10%), agriculture (8%) and construction (4%) as presented in Figure 1.2. The same trend is observed in 2007 as shown in Figure 1.3.

Within the services sector for the year 2007, the finance, insurance, real estate and

12 Health Facts 2008, MOH http://www.moh.gov.my (viewed June 2010)

Table 1.8

Malaysia: Gross Domestic Product and Gross National Income, 2000 - 2007 Current and Constant Prices (2000 = 100)

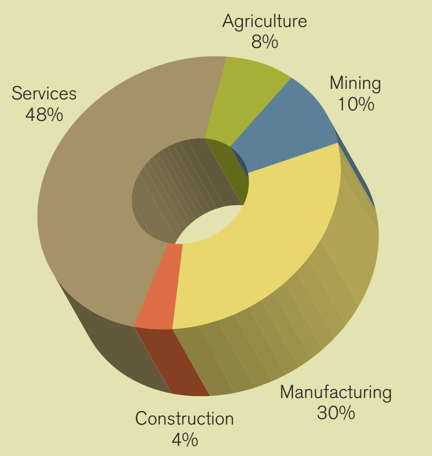
Year	**Gross Domestic Product**		**Gross National Income**		**Gross Domestic Product** per capita	**Gross National Income** per capita
	RM (Million)				RM	
	Current Prices	Constant Prices (2000=100)	Current Prices	Constant Prices (2000=100)	Constant Prices	Constant Prices
2000	356,401	356,401	327,492	327,492	15,169	13,939
2001	352,580	358,246	326,956	331,740	14,919	13,815
2002	383,212	377,559	358,152	351,671	15,394	14,338
2003	418,769	399,414	396,232	376,809	15,946	15,043
2004	474,049	426,508	449,646	402,838	16,673	15,748
2005	522,445	449,250	498,503	424,295	17,194	16,239
2006	574,441	475,526	557,146	455,784	17,850	17,109
2007	642,049	506,341	628,155	482,968	18,633	17,773

Source: EPU Website

business service sub-sector contributed 16 percent, the wholesale, retail trade, accommodation and restaurants sub-sectors contributed 15 percent and the transport, storage and communications sub-sector contributed 8 percent. The remaining sub-sectors are government services (7%); electricity, gas and water (3%) and other services (6%)[13].

Figure 1.2

Share to Gross Domestic Product* (%), 2000 at Constant Prices (2000)

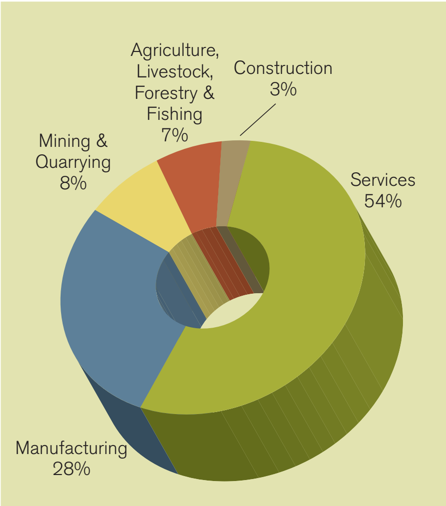


Contribution before deducting undistributed Financial Intermediation Services Indirectly Measured, and without adding import duties

Source: EPU Personal Communication.

13 Due to decimal points the total here adds up to 55% rather than 54% as noted in Figure 1.3

Figure 1.3
Share to Gross Domestic Product* (%), 2007 at Constant Prices (2000)



* Contribution before deducting undistributed Financial Intermediation Services Indirectly Measured, and without adding import duties.
Source: EPU Website

1.7.2 Unemployment

The unemployment rate of Malaysia during the period 2000-2007 was between 3.0 to 3.6 percent. (Table 1.9)

1.8 Energy Sector

1.8.1 Energy Security

In Malaysia, the main thrust of energy policies is on the importance of ensuring adequate, secure and reliable supply of energy at affordable costs in addition to promoting efficient utilisation of energy. Efforts to reduce dependency on petroleum products and environmental considerations are major objectives of more recent policies and in this context, renewable energy which is considered more environmentally friendly has been made the Fifth Fuel after oil, gas, coal and hydro.

The major energy policies implemented in the country are as follow:

(i) National Petroleum Policy (1975)
(ii) National Energy Policy (1979)
(iii) National Depletion Policy (1980)
(iv) Four Fuel Diversification Policy (1981)
(v) Five Fuel Policy (2001)
(vi) Biofuel Policy (2006)

Overall, the country has extensive electricity supply and even very remote rural areas in much of the peninsula are covered. Energy demand and in particular, electricity demand can be expected to grow with population growth and economic growth. Electricity, its production, and supply form an important part of the energy sector. Malaysia's energy needs in the past had been fulfilled with prudent energy policies. As the economy grows and incomes rise, per capita electricity use will increase. Therefore, Malaysia will have to decide today and invest in energy options that will guarantee reliable and affordable energy for the economy while at the same time limiting negative impacts on the environment and safeguarding long-term energy security.

1.8.2 Energy Balance

The major proportion of commercial energy supply in both 2000 and 2007 came from oil and gas as shown in Figures 1.4 and 1.5. Over this period, coal contribution to commercial energy supply has increased while that of other sources has declined. Oil and gas contribution declined from 90.9% to 83.6%.

Final energy demand was 29,699 ktoe in 2000 and 44,268 ktoe in 2007 growing at an average rate of 6.1%. All sectors exhibited growth in energy consumption. Table 1.10 shows the trend of Final Energy Demand by sectors.

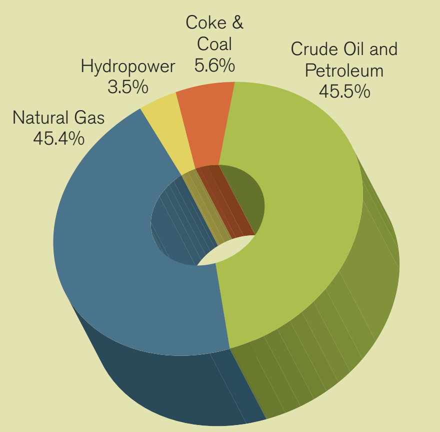
In 2000, 40.6 percent of final energy demand was for transportation. The next highest demand was for industrial purposes at 38.4 percent followed by residential demand at 13.0 percent. The non-energy sector used about 7.5 percent while demand of energy in the agricultural sector was 0.4 percent. These are represented in Table 1.10. In terms of order, industrial demand replaced transportation in 2007.

Table 1.9
Malaysia: Unemployment Rate, 2001 – 2007

	2000	2001	2002	2003	2004	2005	2006	2007
Unemployment Rate (%)	3.0	3.5	3.5	3.6	3.5	3.5	3.3	3.2

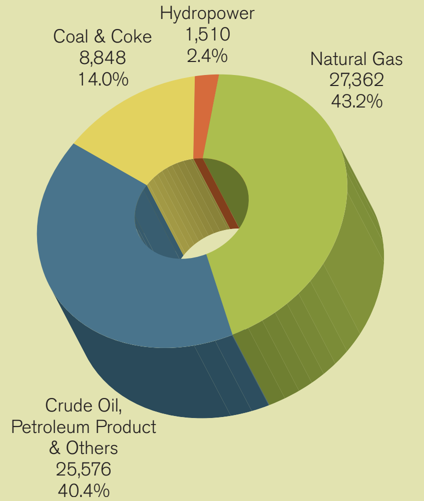
Sources: DOS (2007)[14] and (2009)[15].

Figure 1.4
Malaysia: Commercial Energy Supply, 2000 (ktoe)



Source: Ministry of Energy, Green Technology and Water (2008)[16]

Figure 1.5
Malaysia: Commercial Energy Supply, 2007 (ktoe)



Source: Ministry of Energy, Green Technology and Water (2008)

Table 1.10
Malaysia: Final Energy Demand by Sectors (ktoe)

Sectors	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**
Agriculture	NA	446	104	101	258	281
Non-Energy	908	2,994	2,250	2,173	2,809	2,958
Residential & Commercial	1,646	2,837	3,868	5,134	5,430	6,196
Transport	5,387	7,827	12,071	15,384	14,825	15,717
Industrial	5,276	8,060	11,406	15,492	17,002	19,116
Total	13,217	22,164	29,699	38,284	40,324	44,268

Source: Ministry of Energy, Green Technology and Water (2007)[17]

14 *Malaysia Economic Statistics – Timeseries 2007*
15 *Yearbook of Statistics Malaysia 2008*
16 *National Energy Balance 2008*
17 *National Energy Balance 2007*

1.8.3 Renewable Energy (RE) Programmes

In recent years, RE has been recognised as an option to reduce dependence on fossil fuels. Realising this, the government has increased its role in promoting RE projects and activities. The following are some of the government initiated RE programmes.

Table 1.11
Renewable Energy Programmes

Year	Programmes
1980s	Photo Voltaic (PV) System for Rural Electrification Programme.
1998	First PV Grid Connected System Application.
2001	Formulation of Fifth Fuel Policy. Small Renewable Energy Power Programme (SREP).
2002	Biomass Power Generation and Co-Generation Project (BIOGEN)* .
2004	1st SREP Projects completed: Jana Landfill Project – Puchong, Selangor (Biogas – 2MW) TSH Bio Energy Project – Kunak, Sabah (Biomass – 10MW)
2005	Malaysia Building Integrated Photovoltaic Project (MBIPV).
2006	National Biofuel Policy.

* The Bio-Gen Project has achieved partial success. The Bio-Gas component of the project has developed into a successful full scale model. The Biomass component of the project was unable to achieve its intended objectives and was unsuccessful due to inability to control certain parameters. Nevertheless, other biomass-based renewable energy power plants in the country have continued to operate successfully.

(i) Small Renewable Energy Power (SREP) Programme

In 2001, the Malaysian government launched the SREP programme to encourage and intensify the utilization of renewable energy in power generation. Under this programme, small renewable energy power generation plants can sell up to 30 MW of electricity that has been generated to the utility through the Distribution Grid System. The renewable energy sources that have been identified under this programme are biomass, biogas, solar, mini-hydro and solid waste.

Up to December 2007, only 2 SREP projects were in operation with a total generation capacity of 12MW. The progress of SREP and the development of renewable energy in Malaysia have been generally slow due to a number of issues and barriers that are described and discussed in Chapter 7.

(ii) Solar Energy / Building Integrated Photo Voltaic

The MBIPV project is a national initiative by the Government in collaboration with GEF and UNDP. The MBIPV project is implemented under the 9th Malaysia Plan (9MP) to promote widespread and sustainable use of PV in buildings in order to reduce the long term cost of building integrated photo voltaic (BIPV) technology in Malaysia. The project was officially launched in July 2005 and is too be implemented in five (5) years.

The target is 1,500kWp of installed capacity by the end of the project (2010). Three major components of the MBIPV project are as follows:

(a) showcase;
(b) demonstration; and
(c) *SURIA 1000*[18].

As of December 2007, the capacity that has been awarded under this project amounted to 784kWp.

(iii) PV System for Rural Electrification Programme

The National Electricity Board (now *Tenaga Nasional Berhad*) initiated the use of PV systems for rural electrification in the early 1980s. The first of these was the installation of stand-alone PV systems for 37 houses in Langkawi, followed by other projects in Tembeling (70 houses) and Pulau Sibu (50 houses). Later, in the 1990s, two rural electrification pilot projects, of 10 kWp and 100 kWp respectively were implemented in Sabah with support from the New Energy

18 An initiative to promote PVs.

and Industrial Technology Development Organization (NEDO) of Japan. In the late 1990s the Ministry of Rural Development undertook the role of providing photovoltaic systems for rural electrification. It is estimated that the total capacity for stand-alone systems in Malaysia in 2000 was 1.5 MWp. However, some of these installations have since been dismantled. Presently, installation of solar generating sets and solar hybrids are undertaken for rural villages without electricity supply.

1.9 Other Sectors

1.9.1 Transport

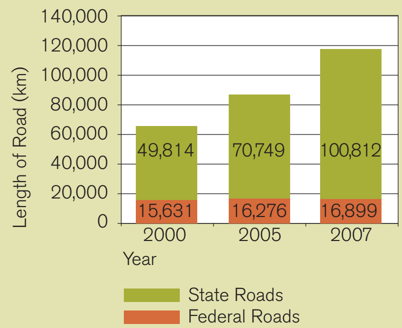
The growth in land transportation is clearly shown in the increase in roads and motor-vehicle registration. There is also growth in the use of public transportation evidenced by the increase in passenger ridership on the light rail transit (LRT) and commuter trains in the Klang Valley, where the capital city of Kuala Lumpur is situated.

In some parts of the country, the land transport network is still underdeveloped compared to other parts of the country; for instance in Sarawak, there are no rail networks passing through rural areas and connecting the main towns. In some of these areas there is a need to upgrade roads in rural and village areas in order to improve accessibility and connectivity between rural and urban areas. In some regions in Sarawak, river transportation is one of the modes of transport for passengers and goods in urban and rural areas.[19]

(i) Roads

In 2000, the total length of roads in Malaysia was approximately 65,445km. The total length of roads increased by 33 percent from 2000 to 2005. From 2005 to 2007, the length of roads increased by 35 percent. Figure 1.6 presents the breakdown of roads into State roads and Federal roads.

Figure 1.6
Malaysia: Length of Roads



Sources: DOS (2003)[20] and (2009)

(ii) Motor-vehicle Registration

There is an increasing trend in motor-vehicle registration for all categories of vehicles. There were 16.8 million registered vehicles in 2007 indicating an increase of 58.5 percent from 2000.

The majority of vehicles registered are motorcycles and motorcars. For 2000, motorcycles represented 51 percent and motorcars represented 38 percent of total motor-vehicle registrations. This percentage changed to 47 percent and 44 percent respectively in 2007.

(iii) Light Rail Transit and Commuter Train

There are four urban rail network lines running though the Klang Valley – Putra, KTM Komuter, Star and the KL Monorail. Statistics of ridership of all these lines show an upward trend from 2000 to 2007. Please refer to Table 1.13.

Currently, only approximately 10 percent (2,662 ha) of Kuala Lumpur is directly served or within the transit catchments of existing transit stations and 20 percent of Kuala Lumpur (5895 ha) are within transit corridors (i.e. areas within 400m on each side of a rail line).

19 UNDP (2008) Malaysia Inland Water Way Transport System in Sarawak.

20 *Yearbook of Statistics Malaysia 2002*

Table 1.12
Malaysia: Motor-Vehicle Registration

Type of Vehicle	2000	2005	2007(p)
Motorcars	4,145,982	6,473,261	7,419,643
Motorcycles	5,356,604	7,008,051	7,943,364
Taxi and Hired Cars	66,585	79,130	84,742
Buses	48,662	57,370	62,308
Goods vehicles	665,284	805,157	871,234
Others*	315,687	393,438	432,652
Total	10,598,804	14,816,407	16,813,943

(p) Provisional
* Including Government motorcars, trailers, and driving school vehicles
Sources: DOS (2003) and (2009)

Table 1.13
Ridership of Rail Transit and Commuter Train 2000 - 2007

	Passenger journeys			
Year	PUTRALINE	STARLINE	KTM-KOMUTER	KL MONORAIL
2000	44,542,496	28,426,201	19,154,197	N.A
2001	52,478,951	32,412,191	20,928,816	N.A
2002	54,423,246	33,471,344	22,084,124	N.A
2003	50,254,365	41,159,817	24,645,493	3,220,297
2004	57,729,971	43,535,471	27,381,423	12,201,518
2005	60,290,467	45,636,997	30,934,651	16,206,441
2006	56,747,136	49,727,909	34,974,974	19,322,170
2007	56,965,258	52,434,883	36,959,339	22,197,169

Source: Ministry of Transport (MOT) (2009)[21]

(iv) Transportation in Urban Areas

In urban centres such as the capital city of Kuala Lumpur, transportation issues are related to the negative impacts of congestion and the need to improve quality of life; greenhouse gas emissions; managing growth of cars; and integrating transport with land use development. Some of the strategic directions towards improving transportation include extending coverage of the urban rail networks and integrating them with regional networks, providing park and ride facilities, and also giving priority to buses.[22]

(v) Railway Statistics

Malaysia has approximately 1,800km of railway tracks. In terms of passenger rail transport statistics for year 2007, there has been a decline in passenger journeys compared to 2000, but increase in terms of passenger kilometre. Please refer to Table 1.14.

21 *Yearbook of Transport Statistics Malaysia (2009)*

22 Kuala Lumpur City Hall (2008) Kuala Lumpur City Plan 2020

Table 1.14
Rail Transport Passenger Data

Year	Number of passenger journeys ('000)	Passenger kilometre ('000,000)
2000	3,825	1,220
2001	3,511	1,181
2002	3,437	1,123
2003	3,362	1,018
2004	3,628	1,139
2005	3,675	1,181
2006	3,794	1,237
2007	3,714	1,309

Source: MOT (2009)

(vi) Air Traffic Statistics

Between 2000 and 2007 there has been a general increase of air traffic passengers (embarkation and disembarkation) from approximately 16 million in 2000 to 22 million in 2007. The ratio of international to domestic passengers has increased for both embarkation and disembarkation showing increasing trends of arrival of international tourists, and also Malaysians travelling abroad as tourists.

1.9.2 Agriculture

The Third National Agricultural Policy (NAP3) outlines the strategic directions for agricultural development from 1998 to 2010. The policy noted an expected decline in contributions from rubber, cocoa and sawn logs while the contribution from oil palm and food commodities were expected to increase. The main thrust of the policy was to focus on new approaches to increase productivity as well as conserve and utilize natural resources in a sustainable manner.

(i) Agricultural Crops

Oil palm and rubber are important agricultural crops for the country that provide income and employment. Efforts are made to ensure that growth in these crops is in line with the sustainable development goals of the country. Some of the sustainable practices introduced include utilization of idle agriculture land, optimization and certification systems of oil palm.

There has been a decline in the land area planted with rubber, cocoa and paddy. Nonetheless, the area planted with paddy is still rather stable because rice is a staple food in Malaysia, as in many countries in

Table 1.15
Air Transport Passenger Data

Year	Embarked			Disembarked		
	Domestic	International	Total	Domestic	International	Total
2000*	9,617,220	6,164,429	15,781,649	9,496,637	6,385,026	15,881,663
2003	10,677,008	5,798,883	16,475,891	10,718,349	5,865,906	16,584,255
2004	11,762,319	7,472,337	19,234,656	11,781,953	7,305,477	19,087,430
2005	10,456,749	8,267,880	18,724,629	11,954,473	8,298,555	20,253,028
2006	12,053,112	8,834,911	20,888,023	11,902,435	8,816,955	20,719,390
2007	12,483,243	9,753,085	22,236,328	12,395,357	9,917,749	22,313,106

Sources: MOT (2009)

* Malaysia Airports Holdings Berhad

South East Asia. Overall the production of rice has increased despite the reduction in areas planted.

Table 1.16 shows the planted areas of major agricultural crops.

(ii) Livestock

Upward trends in livestock were noted for cattle, goats and swine. Sheep however reflected a downward trend. Table 1.17 shows selected livestock population.

(iii) Fisheries

Landings of marine fish were 1.3 million tonnes in 2000 compared to 1.4 million tonnes in 2007. The figure includes shellfish collection. Marine fish are caught using various fishing gears. The majority were from trawl nets, seine nets and drift/grill nets.

Table 1.16
Malaysia: Planted Areas of Major Agricultural Crops

Year / Crops	2000 (‘000 ha)	2005 (‘000 ha)	2006 (‘000 ha)	2007 (‘000 ha)
Rubber	1,344.4	1,272.6	1,263.6	1,247.4
Oil Palm	3,376.7	4,051.3	4,165,2	4,304.9
Cocoa	33.4	33.4	31.3	28.2
Paddy	698.7	666.7 (r)	676.0(r)	674.4

Sources: DOS (2003) and (2009)

Table 1.17
Malaysia: Selected Livestock Population (various years)

Year / Livestock	2000*	2005	2007
Cattle	733,892	781,316	796,550
Goats	237,634	287,670	335,952
Sheep	157,070	115,922	110,415
Swine	1,807,590	2,035,647	2,027,561
Poultry*	123,650,000	174,694,170‡	215,822,110‡ (e)

(e) Estimated figures
Sources: DOS (2009)
* FAOSTATS
‡ Ministry of Agriculture and Agro-based Industry (2008)[23]

Table 1.18
Malaysia: Landings of Marine Fish (various years)

	2000	2005	2007(p)
Landings of Marine Fish (tonnes)	1,271,511	1,209,601	1,381,424

(p) Provisional
Sources: DOS (2003) and DOS Compendium (2009)[24]

23 *Agriculture Statistical Handbook 2008*
24 *Compendium of Environment Statistics Malaysia 2009*

Table 1.19
Malaysia: Aquaculture Production – Brackish and Coastal Areas (various years)

Year	2000	2005	2006	2007(p)
Freshwater (tonnes)	50,688	62,007	61,653	70,056
Brackish water / marine (tonnes)	117,206	145,213	150,374	198,450
Total	167,894	207,220	212,027	268,514

(p) Provisional

Sources: DOS Compendium 2004[25] and 2009[26]

Aquaculture production in Malaysia increased from 0.17 million tonnes in 2000 to 0.27 million tonnes in 2007. Fresh water aquaculture is carried out in ponds, ex-mining pools, cages, cement tanks and also pen cultures. Brackish water marine aquaculture includes sources from ponds, cages and water tanks in brackish water. Table 1.19 presents the breakdown of aquaculture production.

1.9.3 Waste

Solid waste management has traditionally been under the jurisdiction of Local Authorities in Malaysia. However, a new Solid Waste and Public Cleansing Management Act (2007) [Act 672] was gazetted in August 2007. This Act was enacted to allow a centralized and coordinated management of solid waste by the Federal Government of Malaysia with the exception of Sabah and Sarawak. The National Solid Waste Management Department (NSWMD) was established under the Ministry of Housing and Local Government (MHLG) in 2007. The Solid Waste and Public Cleansing Management Corporation was established to handle the day-to-day operation of solid waste and public cleansing.

Based on several studies regarding waste composition, food waste comprises about 50 percent of waste in landfills. Non-organic waste makes up about 10 percent of waste in landfills. A key factor in this ratio is the fact that while other recyclable materials are extracted before entering disposal sites, recovery rates for food waste are negligible.

Table 1.20 shows the breakdown of daily waste generation in the country for 2007.

Table 1.20
Waste Generation in 2007

	Tonnes / day
Peninsular Malaysia	20,500
Sabah	1,210
Sarawak	1,988

(i) Peninsular Malaysia

Based on the summary of waste generation rate in year 2000 from the various states in Peninsular Malaysia, the daily waste generated range from 0.5 kg/capita/day to 1.57 kg/capita/day. Highly urbanized areas within local authority boundaries such as Kuala Lumpur, Pulau Pinang and Johor Bahru produced greater amount of waste, reaching upper limits of 1.6 kg/capita/day. For areas outside local authorities but still within urban settings, the waste generated is between 0.5 to 0.7 kg/capita/day. It is estimated that the waste generated in rural settings outside the jurisdiction of local authorities was approximately 0.3 kg/capita/day[27].

The amount of solid waste generated in Peninsular Malaysia increased from 16,200 tonnes per day in 2001 to 19,100 tonnes in

25 *Compendium of Environment Statistics Malaysia, 2004*

26 *Compendium of Environment Statistics Malaysia 2009*

27 Local Government Department, Ministry of Housing and Local Government (2005) *National Strategic Plan for Solid Waste Management*

2005 or an average of 0.8 kg/capita/day[28].

Based on population growth projections for the period 2002-2020, waste generation is estimated to increase by an average of 3.6 percent per annum. Therefore in Peninsular Malaysia, by 2020, it is estimated that daily solid waste generated will be 31,500 tonnes[29].

(ii) Sarawak

There are 49 landfills established at various local councils throughout Sarawak. 44 of these landfills are categorised as open dumping grounds and five (5) are categorised as sanitary landfills[30].

Approximately 1988 tonnes of municipal solid waste were disposed at these landfills daily or equivalent to 725,620 tonnes annually[31]. As of 2007, Kuching Integrated Waste Management Park (KIWMP) in Mambong, Kuching, which started operating in 2003, received the highest volume of waste amounting to 450 tonnes per day.

(iii) Sabah

In Sabah, managing solid waste has become a major challenge for local authorities, with a population of 3.06 million in 2007 and growing at 2.2 percent annually. The 22 local authorities collected 356,830 tonnes of waste in 2007. This amount increases by 2-3 percent every year according to the Ministry of Local Government and Housing, Sabah.

In 2007, there were one landfill and 16 operational dumpsites. With the completion of the 'Solid Waste Management Master Plan' study in Sabah which covers a 30 year period from 2007-2036, Sabah has found new direction in managing solid waste, since the study has spelt out practical, efficient and systematic ways of handling solid waste. This includes continuing to promote waste minimization, strengthening the legal and institutional framework and using cost effective and environmentally friendly technologies.

28 Economic Planning Unit (2006) Ninth Malaysia Plan (2006-2010)

29 Local Government Department, Ministry of Housing and Local Government (2005) *National Strategic Plan for Solid Waste Management*

30 National Resources and Environment Board (*NREB) Environmental Quality Report 2007*

31 *NREB Environmental Quality Report 2007*

1.10 Institutional Arrangement

The issue of climate change covers many sectors and as such is the concern of a wide range of institutions within the country. Overall changes to improve environmental management since the preparation of the INC have also advanced the country's ability to cope with the complex issues of climate change. The Ministry of Natural Resources and Environment (NRE) was formed in 2004. In terms of climate change, this development has enabled better coordination as some of the key agencies which were previously in various ministries are now under NRE.

Malaysia generally adopts a "precautionary principle" approach and "no regrets" policy and applies this in action that should be taken to adapt to or mitigate climate change. Government agencies, the private sector and non-governmental organisations (NGOs) work harmoniously together through appropriate initiatives to address climate change. Greater public awareness has resulted from such initiatives and mutually beneficial cooperation has increased between the formal and informal sectors to better tap into each other's respective strengths towards the common goal of addressing climate change.

Chapter 2

GREENHOUSE GAS INVENTORY

CHAPTER 2:
GREENHOUSE GAS INVENTORY

2.1 Methodology for Greenhouse Gas Emissions Calculation

The GHG inventory described in this chapter documents the anthropogenic emissions and removals for the year 2000. The Revised IPCC 1996 Guidelines were used in line with Decision 17/CP.8 of UNFCCC Conference of Parties (COP) 8. Data to prepare the inventory were acquired from national and international statistics and stakeholder inputs. Local emissions factors were applied where available and the IPCC's default values were used otherwise.

2.2 Improvements in Current GHG Inventory Preparation

The NC2 has achieved significant improvements in the preparation of the GHG inventory. Stakeholders were engaged either directly or indirectly throughout the process. Key categories were disaggregated and expanded in the Energy sector while additional categories have been included in the Industrial Processes and LULUCF sectors. The key categories included in this inventory as compared with the INC are reported in Table 2.1.

The Good Practice Guidance 2000 (GPG) characteristics were employed to improve transparency, consistency, comparability, completeness and accuracy in the inventory.

2.3 Major sources of GHG emissions

Malaysia's GHG emission was 222.99 Mt CO_2 eq in 2000 and removal was 249.78 Mt CO_2 eq. The net emission after accounting for the removal was -26.79 Mt CO_2 eq, thus indicating that Malaysia was a net sink in 2000 (Table 2.2).

Increases in emissions in the Energy, Industrial Processes and Waste sectors ranged between 50-184 percent (Figure 2.1) between the years 1994 and 2000 resulting in a significant increase in emissions of each GHG considered (Figure 2.2). At the same time, there was a 260 percent increase in net removal in the LULUCF sector largely due to the increase in categories considered (Table 2.1) and better accuracy in calculations. The Agriculture sector showed a reduction in emissions due to the changes in assumptions and guidelines.

In the INC inventory for 1994, the Energy sector contributed about 68 percent of the total emissions followed by the Waste sector, which accounted for 19 percent. In NC2, the Energy sector contributed 66 percent, LULUCF sector 13 percent, and Waste sector 12 percent (Figure 2.3).

Again, the additional sub-sectors considered in the LULUCF sector resulted in an increase in its percentage emission contribution to the overall total.

The Industrial Processes sector ranked higher than the Agriculture sector in GHG emissions in the NC2, whilst the converse was true for the INC. This is due to additional sectors being considered for Industrial Processes in NC2.

Most Non-Annex 1 (NA1) countries reported that the Energy sector followed by the Agriculture sector, were the major contributors to greenhouse gas emissions in their Initial National Communications (INC). Malaysia had a different ranking, where the Energy and Waste sectors were the highest contributors of the greenhouse gas emissions in the INC.

While Malaysia reported net emissions in the INC, for NC2, Malaysia was a net sink based on more accurate and expanded calculations.

Carbon dioxide (CO_2) emissions amounted to about 75 percent of the total greenhouse gas emissions (Figure 2.4) in 2000, higher than the INC (69 percent). The global average of CO_2 emissions for NA1 countries based on the INC was 63 percent of their total emissions, amounting to an equivalent of 7.4 billion tCO_2 (UNFCCC, 2005)[32].

32 Sixth compilation and synthesis of initial national communications from parties not included in Annex I to the Convention. FCCC.SBI/2005/18.

Table 2.1
A Comparison between Key Categories within Sectors between INC (1994) and NC2 (2000)

Key categories	INC 1994	NC2 2000
Energy (Sectoral Approach[33])		
• Energy industries	–	√
• Transport	√	√
• Manufacturing industries and construction	√	√
• Residential & commercial	√	√
• Agriculture	√	√
• Others	√	√
(calculation using the Reference Approach[34] was also done for both inventories)		
Industrial Processes		
• Mineral Products	√	√
– Cement production	–	√
– Lime production	–	√
– Limestone & dolomite use		
• Chemical Industry	–	√
– Ammonia production	–	√
– Nitric acid production	–	√
– Carbide production	–	√
– Petrochemicals		
• Metal Production	–	√
– Iron & steel production		
Agriculture		
• Domestic livestock enteric	√	√
• Manure management	√	√
• Flooded rice fields	√	√
• Burning of agricultural residues	√	√
Land Use Land Use Change and Forestry		
• Natural forest		
– Permanent forest reserves	-	√
– State land	-	√
• Plantation forest	√	√
• Plantation crops		
– Rubber	√	√
– Oil palm	√	√
• Urban forestry	-	√
• Bamboo and rattan	-	√
• Abandonment of managed land	-	√
• Soil	-	√
Waste		
• Landfill	√	√
• Domestic & commercial wastewater treatment	√	√
• Industrial waste water treatment		
– Rubber SMR	√	√
– Rubber Latex	√	√
– Oil palm	√	√

33 Sectoral Approach: estimation of CO_2 from fuel consumption data without considering the type of combustion or “bottom up” approach.

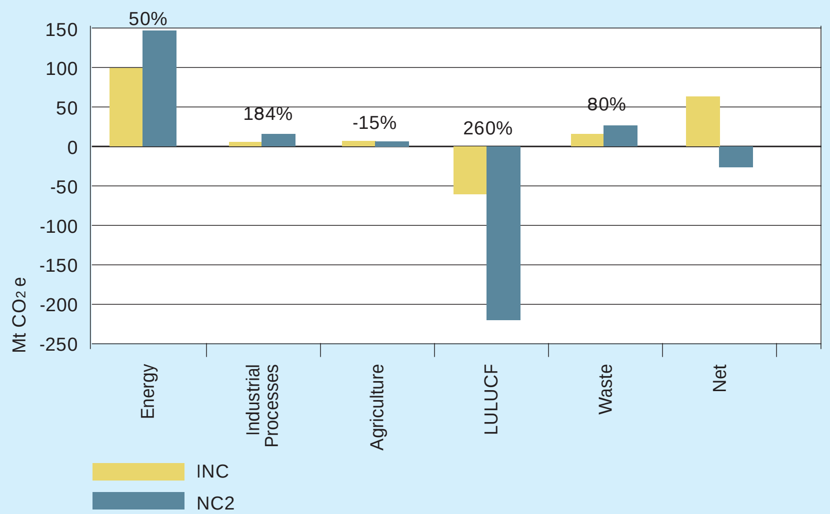
34 Reference Approach: estimation of total CO_2 from fuel supplied to the country or “top down” approach.

Table 2.2
Emissions and Removal of Greenhouse Gas for each Sector in 2000

Sectors		Emissions (Gg) A	GWP B	CO_2 eq (Gg) C = (A x B)
Energy	CO_2 CH_4 N_2O	125,005 1,047 0.03	1 21 310	125,005 21,987 9
Sub-total				**147,001**
Industrial Processes	CO_2 CH_4 N_2O HFC SF_6	13,690.00 4.28 0.66 0.11 0.00026	1 21 310 1,300 23,900	13,690 89.88 204.6 143 6.2
Sub-total				**14,133.7**
Agriculture	CH_4 N_2O	153.33 8.66	21 310	3,220 2,686
Sub-total				**5,906**
Land Use Land Use Change and Forestry (emissions)	CO_2 CH_4 N_2O	28,750 36.3 0.25	1 21 310	28,750 762.3 77.50
Sub-total				**29,589.8**
Waste	CH_4	1,255.1	21	26,357.1
Sub-total				**26,357.1**
Total emissions				**222,987.6**
Land Use Land Use Change and Forestry (sink)	CO_2	-249,784	1	**-249,784**
Net Total (after subtracting sink)				**-26,796.4**

- indicates sink

Figure 2.1
Comparison of Greenhouse Gas Emissions by Sectors between INC and NC2

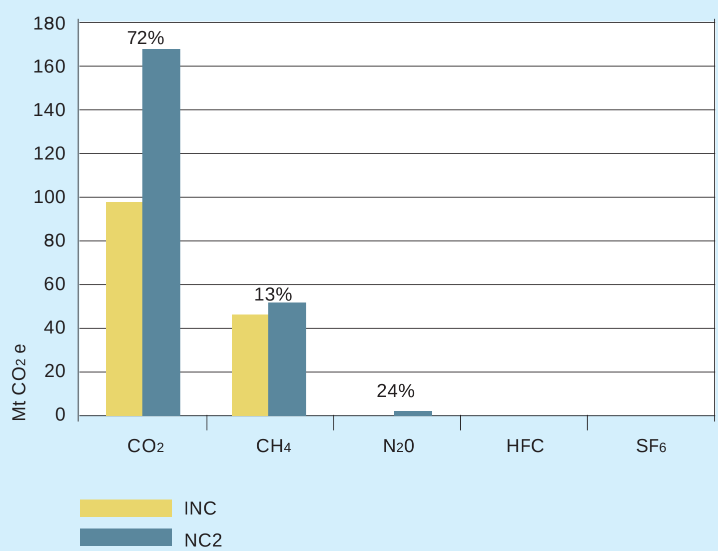


Note:

(1) Percentage indicates the increase or decrease of emissions or removals relative to the INC.

(2) With regards to the Waste Sector, INC is based on the recalculated value using the Revised 1996 IPCC Guidelines.

Figure 2.2
Comparison of Greenhouse Gas Emissions by Gases between INC and NC2



Note:

(1) Percentage indicates the percent of emission increase

Figure 2.3
Percentage of Greenhouse Gas Emission by Sectors in 2000

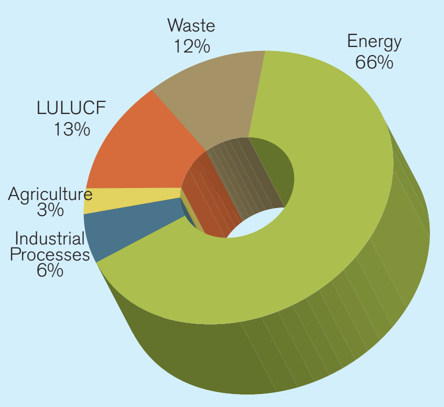
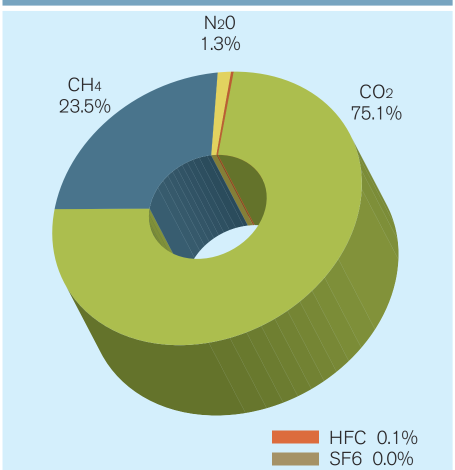


Figure 2.4
Percentage Emissions According to Greenhouse Gases in 2000



Methane (CH_4) emissions amounted to about 24 percent of the GHG emissions, as compared to INC, about 30 percent. The global average of CH_4 emissions for NA1 countries based on the INC was 26 percent of their total emissions (UNFCCC, 2005). Nitrous oxide (N_2O) accounts for a very small portion of the greenhouse gas emissions, 1.3 percent for the year 2000. In the INC, 0.2 percent of the total emissions were from N_2O. Due to the relatively low emissions from the Agriculture sector, Malaysia's total N_2O emission is very much lower than the global average of 11 percent for NA1 countries reported in their respective INCs.

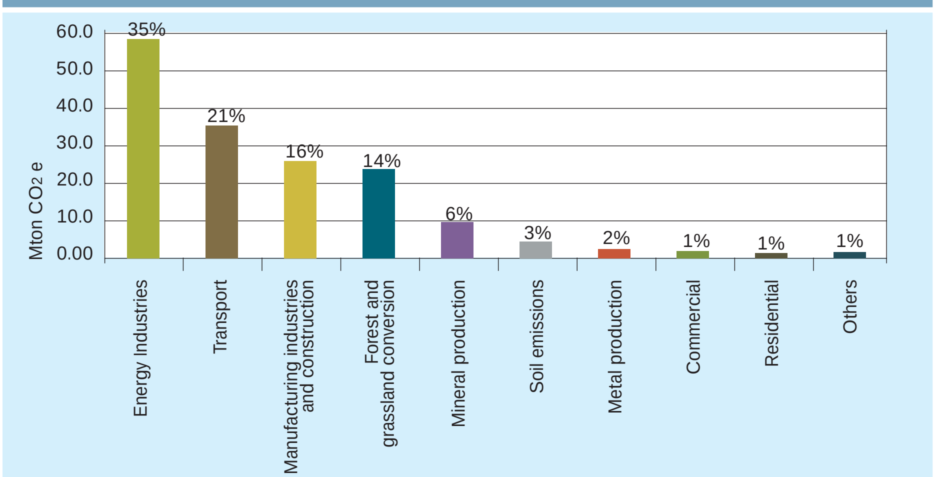
2.4 Major Sources of CO_2 Emissions

In 2000, a total of 167.44 Mt CO_2 was emitted. Emissions from energy industries was the highest at 58.48 Mt CO_2 (35%) followed by emissions from transport (21%) as shown in Figure 2.5. Emissions from energy industries are due to the fuel used by the power and auto producers (self energy producers) for producing electricity, petroleum refining and natural gas transformation. Manufacturing industries & construction was the third largest contributor to CO_2 emissions (16%). Forest and grassland conversion was the fourth at 14 percent.

2.5 Major Sources of CH_4 Emissions

A total of 52.41 Mt CO_2 eq was emitted. The highest emission was from landfills

Figure 2.5
Major Sources of CO_2 Emissions



(solid waste), which accounted for about 47 percent and followed closely by fugitive emissions from oil and natural gas, amounting to 42 percent (Figure 2.6).

2.6 Major Sources of N_2O Emissions

N_2O emissions were primarily from the Agriculture sector as shown in Figure 2.7. A total of 29.77 Mt CO_2 eq was emitted.

2.7 CO_2 Removal

CO_2 removal occurred in the LULUCF sector. The net removal from the LULUCF sector amounted to 220.19 Mt CO_2. Figure 2.8 shows the gross distribution of carbon removal of forest and land use categories, where emissions from commercial harvesting is not included. In the Asia Pacific region, the LULUCF sector accounted for the removal of 316 Mt CO_2 as reported in UNFCCC 2005.

Figure 2.6
Major Sources of CH_4 Emissions

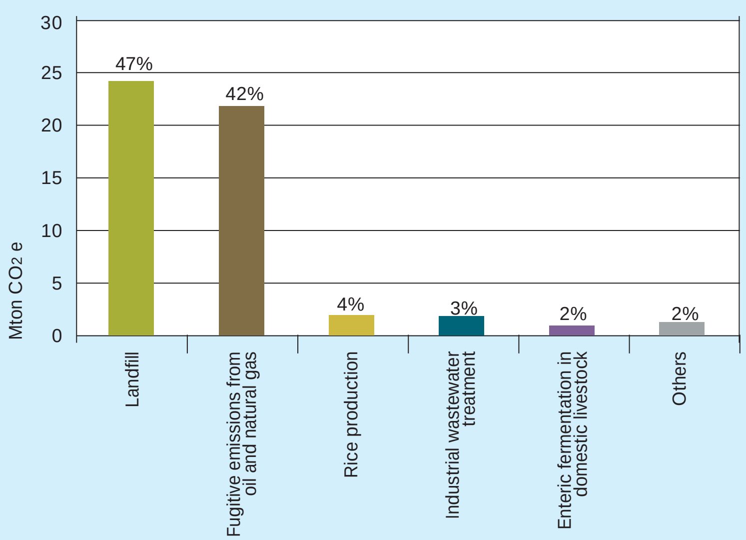
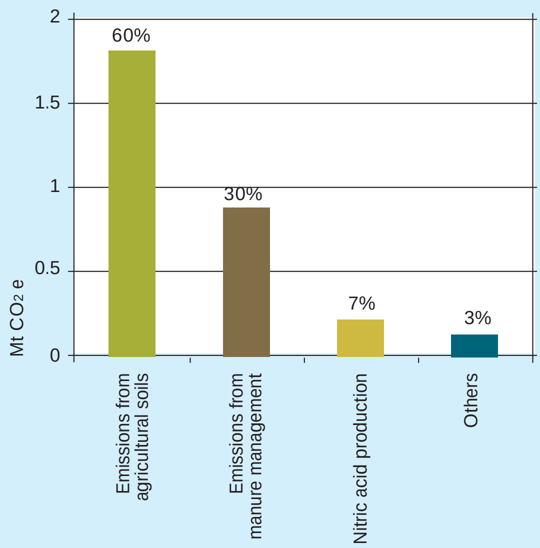


Figure 2.7
Major Sources of N_2O Emissions



2.8 Greenhouse Gas Emissions against Development Indices

Total greenhouse gas emissions increased by 55 percent in 2000 (NC2) when compared with 1994 (INC). Greenhouse gas emissions increased by 13 percent per GDP and 32 percent per capita between 1994 and 2000 (Table 2.3).

2.9 Emissions Time Series from 1990 - 2007

Time series emissions for Energy, LULUCF, Agriculture and Waste sectors are shown in Figures 2.9, 2.10, 2.11 and 2.12. The trend in the Energy sector emissions follows the GDP trend of the country (National Energy Balance Report, PTM 2007). The increasing trend in the Waste sector is mainly due to an increase in solid waste generation arising from population growth. Emissions from LULUCF and Agriculture sectors have stabilized.

Figure 2.8
Gross Carbon removal by Various Forest and Land Use Categories, 2000

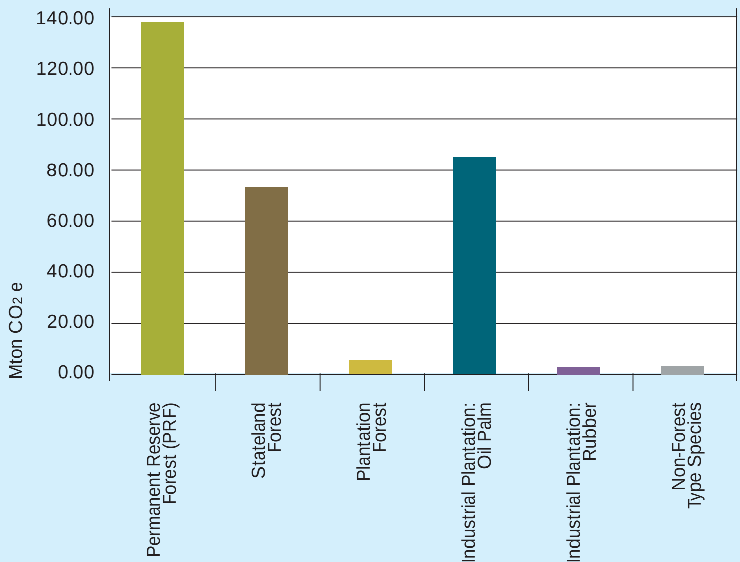
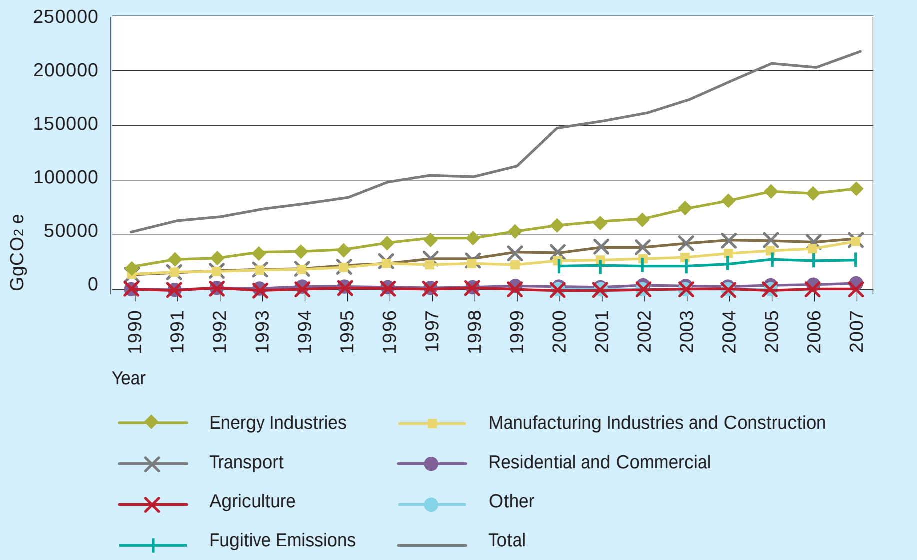


Table 2.3
GHG Emissions for Malaysia

	Unit	(INC) 1994	(NC2) 2000	% increase
GDP	RM million	261,951	356,401	36%
Population	Million	20.1	23.5	17%
CO_2 equivalent	Mil tonne	144.3	223	55%
CO_2 equivalent per GDP	tonne/thousand RM	0.55	0.62	13%
CO_2 equivalent per capita	tonne/capita	7.2	9.5	32%

Figure 2.9

Emissions Time Series from 1990 to 2007 for Various Sub-sectors within the Energy Sector



Note: Fugitive emissions from 1990 to 1999 are not available. For the residential and commercial, the data was not available until the year 1996. For agriculture, there were no data for the year 1990.

Figure 2.10

Emissions Time Series from 1990 to 2007 for LULUCF Sector

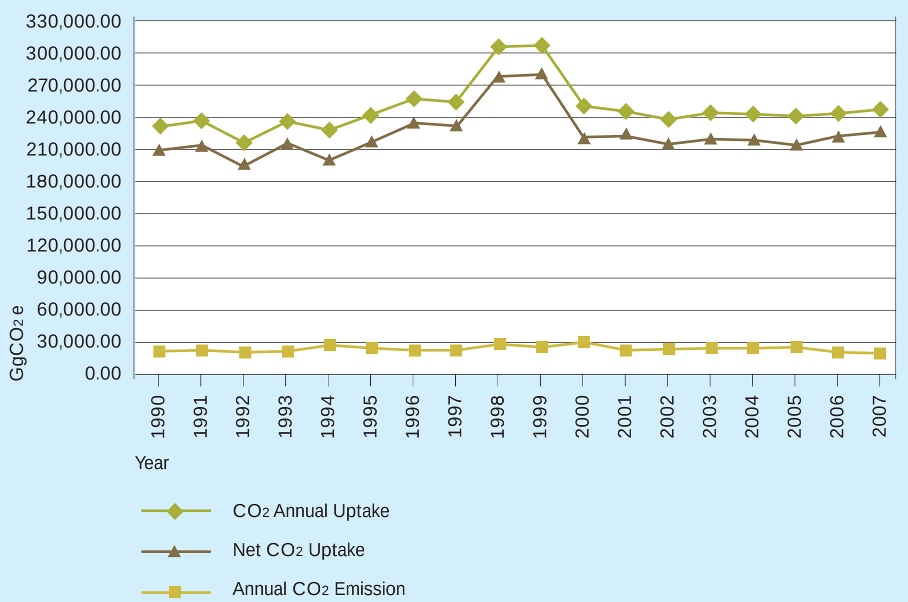
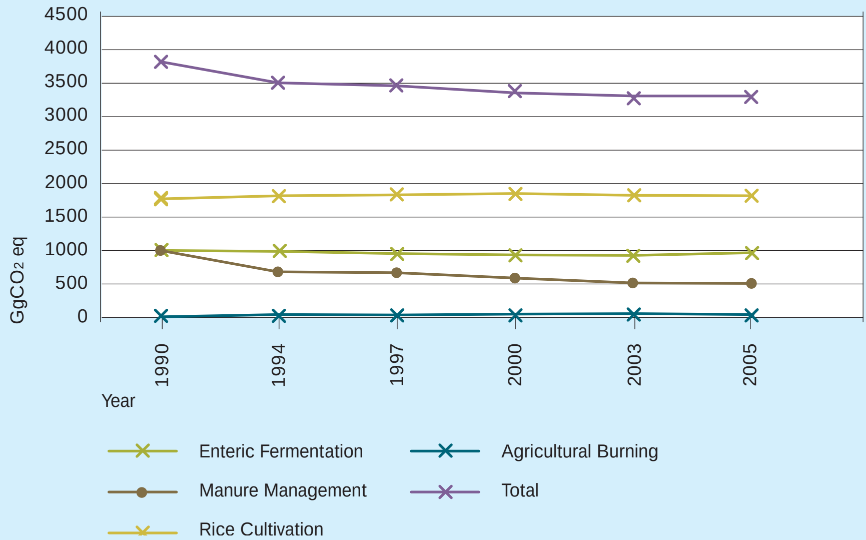
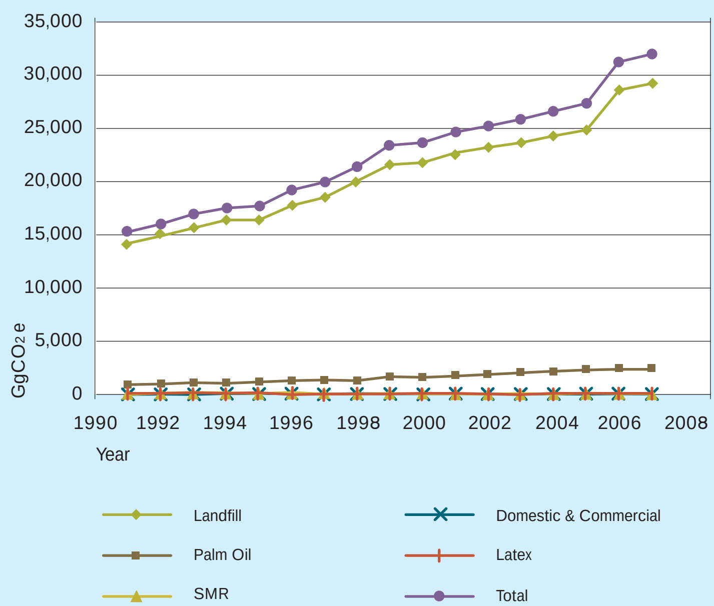


Figure 2.11
Emissions Time Series from 1991 to 2005 for Agriculture Sector*



* Emission from Agriculture Soils is not included

Figure 2.12
Emissions Time series from 1991 to 2007 for Waste Sector



Note:

For Domestic and Commercial, total emissions were between 30 to 60 Gg CO_2 e.

The difference for year 2000 between Figure 2.12 and Tables 2.2 and 2.4 is due to using different data sets. For Table 2.2, detailed state by state data was used whilst the time series projection (Figure 2.12) was based on national average population data.

Table 2.4
Greenhouse Gas Emission for 2000 and Estimates for 2005 and 2007

Sector	Emissions/removal (Mt CO_2 eq)		
	2000 (Actual)	2005	2007
Energy	147	204.3	217.0
Industrial Processes	14.1	15.6	17.1
Agriculture	6.0	6.6	7.2
LULUCF	29.6	25.3	19.7
Waste	26.4*	27.4	31.9
Total emissions	223.1	279.2	292.9
Total sink	-249.8	-240.5	-247
Net total (after subtracting sink)	-26.7	38.7	45.9

* The difference between Figure 2.12 and Table 2.4 is due to using different data sets, i.e. inventory for year 2000 was based on detailed state by state data whilst the time series projection was based on national average population data.

Table 2.5
Key Source Analysis for Greenhouse Gas Emissions for Year 2000, with LULUCF

Sector	Key category	GHG	Emissions (Gg CO_2 eq)	Level assessment (%)[35]	Cumulative total (%)[36]
Energy	Energy industries	CO_2	58,486	26.2	26.2
Energy	Transport	CO_2	35,587	16.0	42.2
Energy	Manufacturing industries and construction	CO_2	26,104	11.7	53.9
Waste	Landfills	CH_4	24,541	11.0	64.9
LULUCF	Forest and grassland conversion	CO_2	24,111	10.8	75.7
Energy	Fugitive emissions from oil and gas systems	CH_4	21,987	9.9	85.6
Industrial processes	Mineral products (cement production, lime production and limestone and dolomite use)	CO_2	9,776	4.4	90.0
LULUCF	Emissions and removals from soil	CO_2	4,638	2.1	92.1
Industrial processes	Metal production (iron and steel production)	CO_2	2,797	1.3	93.4
Energy	Commercial	CO_2	2,122	1.0	94.4
Agriculture	Rice production	CH_4	1,861	0.8	95.2

35 Level assessment refers to the contribution of each key category in relation to the total amount of emissions expressed in percentage

36 Cumulative total refers to the cumulative total of the level assessment percentages. Sources of emissions contributing up to the 95% cumulative total are deemed to be key sources.

2.9.1 Greenhouse Gas Emissions for Years 2000 and Estimates for 2005 and 2007

Greenhouse gas emissions for 2000 and estimates for 2005 and 2007 are shown in Table 2.4. In the year 2000, Malaysia was a net sink but in 2005 Malaysia likely became a net emitter. This change from net sink to net emitter was due to the significant increase in GHG emissions from the Energy sector and at the same time the LULUCF sector's sink capacity has stabilized. The rates of forest conversion have also decreased as indicated by the reduction in emissions from LULUCF.

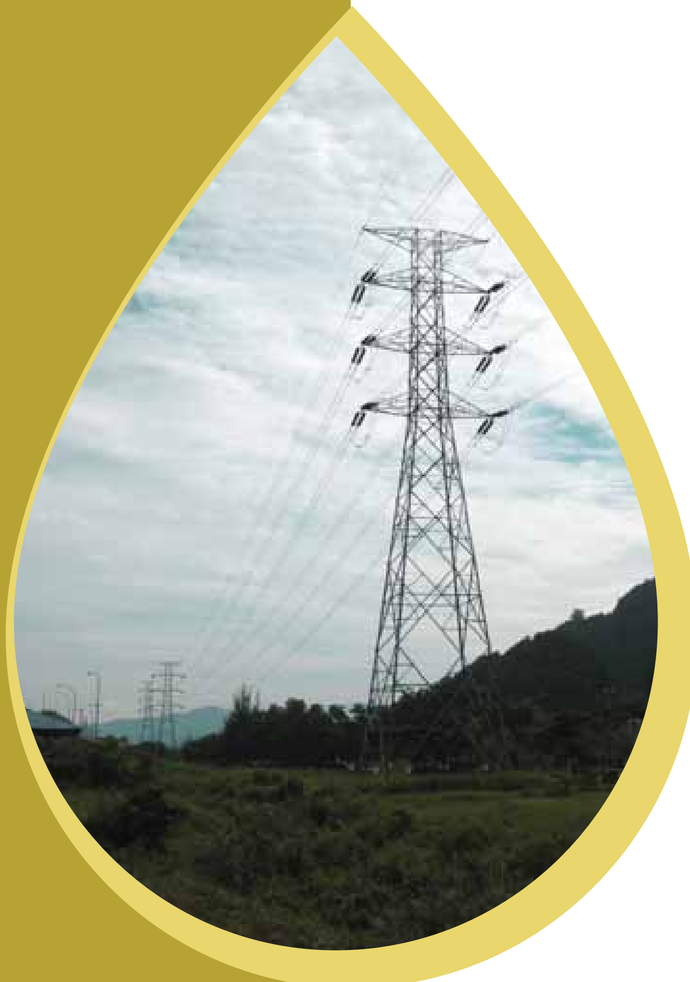
2.10 Analysis of Key Source Assessment for the NC2

Compared to the INC, the NC2 further disaggregates sources of greenhouse gas emissions This has provided a better source analysis for mitigation options.

For 2000, the highest emissions were from energy industries, followed by transport and the manufacturing industries and construction respectively which ranked as key sources (Tables 2.5 & 2.6). Emissions from solid waste from landfills is ranked fourth. The Agriculture sector is not a high ranking key source in Malaysia simply because rice cultivation and animal husbandry activities are relatively small.

Table 2.6
Key Source Analysis for Greenhouse Gas Emissions for Year 2000, without LULUCF

Sector	Key category	GHG	Emissions (Gg CO_2 eq)	Level assessment (%)	Cumulative total (%)
Energy	Energy industries	CO_2	58,486	30.0	30.0
Energy	Transport	CO_2	35,587	18.4	48.4
Energy	Manufacturing industries and construction	CO_2	26,104	13.5	61.9
Waste	Landfills	CH_4	24,541	12.7	74.6
Energy	Fugitive emissions from oil and gas systems	CH_4	21,987	11.4	86.0
Industrial processes	Mineral products (cement production, lime production and limestone and dolomite use)	CO_2	9,776	5.1	91.1
Industrial processes	Metal production (iron and steel production	CO_2	2,797	1.5	92.6
Energy	Commercial	CO_2	2,122	1.1	93.7
Agriculture	Rice production	CH_4	1,861	1.0	94.7
Energy	Residential	CO_2	1,812	1.0	95.7
Energy	Residential	CO_2	1,812	1.0	95.7



Chapter 3

MITIGATION ANALYSIS

CHAPTER 3: MITIGATION ANALYSIS

3.1 Introduction

As a developing country Malaysia needs to continue implementing intensive sustainable economic development. Rapid growth is a national priority. This is to be achieved in a responsible manner and Malaysia has identified mitigation measures in the context of the development process. In this regard, Malaysia voluntarily aspires to the scenario of reducing the GHG emission intensity of GDP by up to 40 percent of 2005 levels by 2020 as announced by the Rt Hon Prime Minister in Copenhagen during COP 15.

Based on the key source analysis in the GHG Inventory chapter (Chapter 2) which identifies major sources of emissions, Table 3.1 identifies potential mitigation options in the relevant sectors of energy, LULUCF, waste, agriculture and industrial processes.

Some of these options are considered in greater detail in light of existing initiatives or policies guiding Malaysia's development that could potentially also result in emissions reductions as well.

The mitigation assessments were prepared with reference to business-as-usual (BAU) baseline projections from 2000 until 2020, taking into account national economic and social policies, development trends and projections. The assessments then consider the emission reduction potential of certain interventions if successfully implemented. Apart from the emissions reduction potential, where possible, the assessments also include a cost analysis, identification of barriers to implementation, assessment of technology options for different mitigation options, institutional capacity-building needs to sustain mitigation work, and related legal and institutional frameworks. They also include the identification of some potential cross-sectoral issues.

Finally, the chapter provides an assessment of the potential contribution of the mitigation options considered in this chapter towards the scenario of emissions intensity reduction of GDP by up to 40 percent of 2005 levels by 2020.

3.2 Mitigation Assessment For Each Sector

3.2.1 Energy Sector

In the year 2000, Malaysia's primary energy resources were oil, gas, coal and hydropower. Oil and gas constituted almost 92 percent of the primary energy[37] supply, with the remaining being taken up by coal (5 percent) and hydropower (3 percent). The main sources of primary energy supply in 2000 amounted to 50,710 ktoe while the final demand was 29,699 ktoe. The average annual growth rates were 8.97 percent and 8.43 percent per year from the years 1990 – 2000. In 2000, the energy intensity (measured by the quantity of energy required per unit output or activity) of primary energy was 142 toe/GDP at 2000 prices (RM million), while the energy intensity for final energy was 83 toe/GDP, also at 2000 prices (RM million).

For developing the mitigation assessment, a baseline was first developed. The basic assumptions for the baseline include the estimation of population from DOS (Table 3.2) and GDP projections from the EPU (Table 3.3).

Total population is expected to reach 32.76 million by the year 2020. As Malaysia's economy matures, the GDP is expected to grow at a slower rate of about 4.9 percent per annum for the period 2000-2020 compared to the preceeding 15 years (1986-2000) with 6.2 percent per annum.

37 Primary energy is energy embodied in sources from human induced extraction or capture, with or without separation from contiguous material, cleaning or grading, that must be undertaken before the energy can be traded, used or transformed. Primary energy supply = Production + imports – exports – bunker fuels – stock change.

Table 3.1
Potential Mitigation Options in Key Sectors

Sector	Potential Mitigation Options			
Energy	Implementation of RE for power generation	Implementation of EE in the industry, commercial and residential sector	Implementation of RE in the industrial, commercial and residential sector	Transportation - Hybrid (hydrogen, fuel cell) & electric vehicles, integrated public transportation system, bio fuels, low carbon petrol & diesel
LULUCF	Maintain existing forest cover	Reduce emission from forest and land use related activities	Where appropriate, to increase existing forest cover	
Waste	Encourage methane capture facilities at new sanitary landfills	Encourage palm oil millers to capture biogas for power generation	Encourage composting of organic waste, especially food waste and 3R (Reduce, Reuse and Recycle)	
Agriculture	Rice Management with water saving production: • Intermittent flooding • Aerobic rice	Livestock waste management through • Aerobic manure composting • Biogas capture	Partial replacement of synthetic Nitrogenous Fertilizer	
Industrial Processes	Employ processes to reduce clinker use in cement production			

Table 3.2
Population Increase Outlook, 2000 – 2020

Period	Percentage (%)
2000-2010	1.89
2011-2020	1.68

Source: DOS 2009

Table 3.3
Gross Domestic Product (GDP) Growth and Projection, 2000 - 2020

Period	Percentage (%)
2000-2005	4.70
2006-2010	3.75
2011-2020	5.50

Source: EPU, 2009[38]

38 Some revisions have been made since the LEAP modelling as reflected in the National Circumstances Chapter.

(i) Projected Outlook

The final and estimated final energy demand[39] in Malaysia by sector is shown in Figure 3.1. It is projected to grow at an annual rate of 4.8 percent from 2000 to 2020 in the business-as-usual (BAU) scenario. In this period, the industrial sector's final energy demand is expected to increase at an average annual growth rate of 5.0 percent while the transport sector's final energy demand is projected to increase at an average annual rate of 4.7 percent. The combined commercial and residential sector's final energy demand is expected to increase at an average annual rate of 5.6 percent and that of the agricultural sector, by an average of 5.1 percent per annum. Non-energy Use is expected to grow at an average of 4.5 percent per annum.

The final energy demand by fuel type as shown in Figure 3.2 is projected to reach almost 80 Mtoe by 2020. Electricity is projected to grow at 5.7 percent per annum from 2000 until 2020 in view of the higher proportion consumed by the commercial/ domestic sectors. The share of electricity demand to total energy demand is expected to increase from 17.2 percent in 2000 to 20.3 percent by 2020. Final demand of natural gas is expected to grow at an average rate of 7.0 percent per annum. The share of natural gas should increase from 12.6 percent in 2000 to 19.1 percent in 2020. The share of oil is expected to decrease from 64.1 percent in 2000 to 56.9 percent in 2020. The average annual growth rate of oil final demand from 2000 until 2020 is expected at 5.0 percent.

(ii) Commercial Energy Supply

Malaysia's commercial energy supply[40] is expected to grow at an annual rate of 3.8 percent from 2000 until 2020. The commercial energy supply for coal and coke is expected to increase at an annual rate of 9.1 percent from 2000 to 2020. The increase in commercial energy supply from coal over the next 20 years is largely due to the use of coal as fuel in the power generation sector.

Natural gas consumed mainly by the thermal stations, industries and for non-energy purposes, will be expected to grow at 3.3 percent per annum from 2000 until 2020. However, the share of natural gas in the primary supply mix is expected to reduce from 30.3 percent in 2000 to 27.1 percent in 2020 due to the increased share of coal and oil. The commercial energy supply of oil is expected to increase at an average annual rate of 3.1 percent from 2000 to 2020, in view of the increasing consumption by the transport sector. (Figure 3.3)

(iii) Mitigation Assessment

Two energy modelling software packages were used in this assessment i.e. Long-range Energy Alternative Planning (LEAP) System and *Microfit*[41]. The demand equations using *Microfit* took several factors into consideration such as GDP growth, population growth, crude oil prices and other socioeconomic indicators. All the demand equations and future assumptions were inputs into LEAP which generated CO_2 emissions projections based on BAU and these assumptions until 2020. The LEAP model structure is based on the Energy Balance format and covers power; residential and commercial; industry; transport; non-energy; and losses of oil and gas[42]. These sectors are key contributors to CO_2 emissions. On the supply side, the analysis focused on the power sector whereas on the demand side, the analysis focused on the industrial, transport and commercial sectors.

Table 3.4 shows the assumptions for the main mitigation options for the energy sector.

39 Final energy demand refers to the quantity of energy of all kinds delivered to the final user.

40 Commercial Energy Supply refers to the supply of energy that has not undergone a transformation/ conversion process within the country after removing energy transformed in the country and exported such as liquefied natural gas (LNG). Hence commercial energy supply = Primary Energy Supply – LNG exports.

41 Microfit is an econometric software to generate the demand equations for each of the fuels and sectors.

42 Losses of oil and gas is the difference between the input and output of the plant

Figure 3.1
Final Energy Demand by Sectors, 2000 – 2020
Scenario: BAU, Fuel: All Fuels

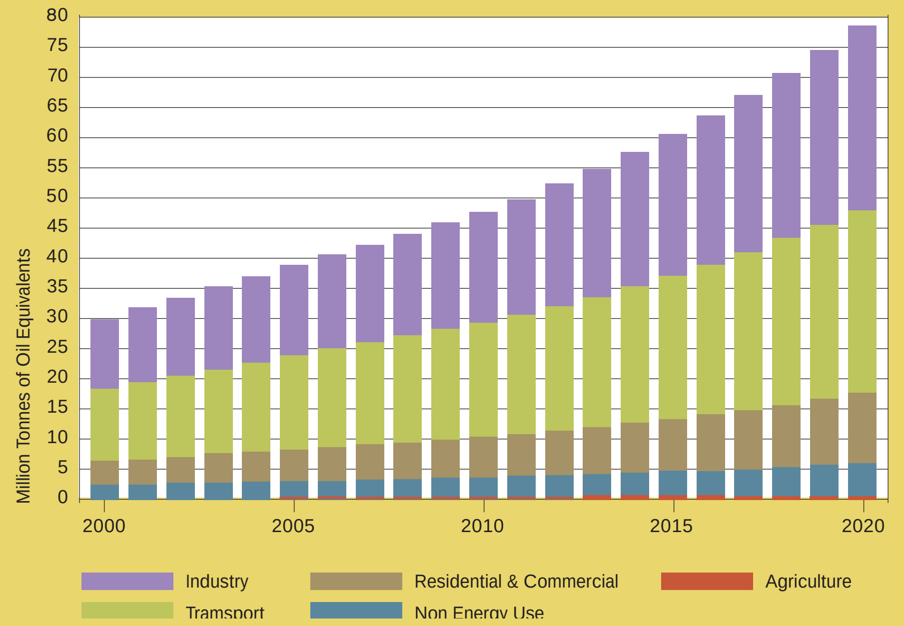


Figure 3.2
Final Energy Demand by Type of Fuel, 2000 - 2020
Scenario: BAU

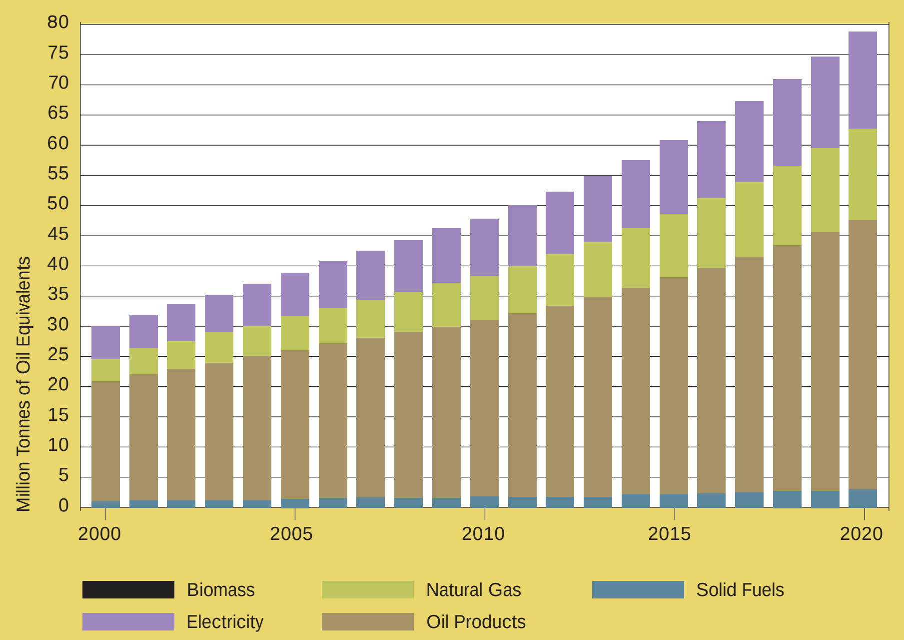
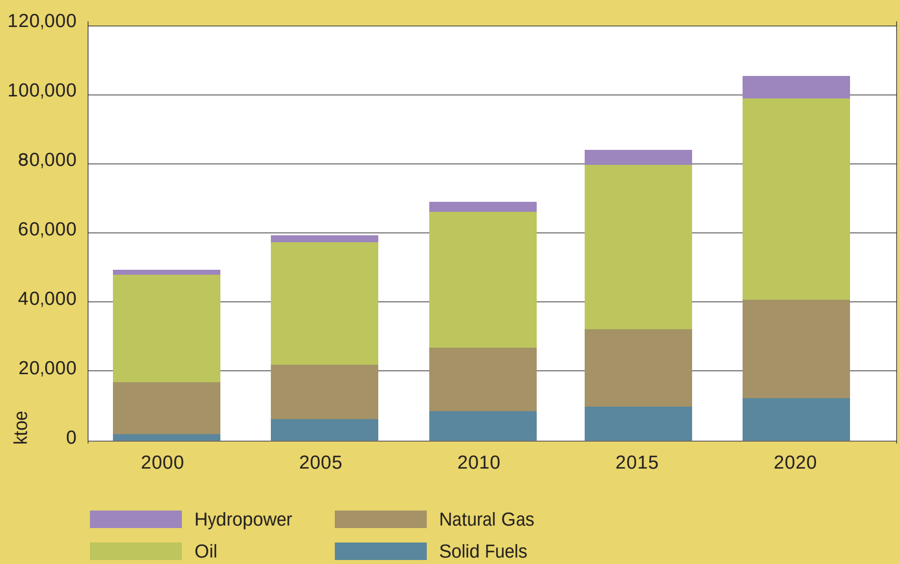


Figure 3.3
Commercial Energy Supply by Type of Fuel, 2000 – 2020



The energy efficiency scenario was based on the outcome of the energy audits conducted by the Malaysian Industrial Energy Efficiency Improvement Programme (MIEEIP). According to the energy audits under the Energy Efficiency and Conservation (EEC) scenario, the electricity demand in the industrial sector will have potential savings of 0.8 percent per annum from year 2015 until 2020. In terms of final energy demand in the industrial sector, the total potential saving is expected to be about 1.0 percent per annum from 2015 until 2020.

The grid connected RE capacity by 2020 is based on the National Renewable Energy Policy and Action Plan. By then, Malaysia is expected to have a total of 2,080 MW grid-connected RE capacity while by 2015, it is anticipated that 5 percent diesel consumption for the transport sector will come from biodiesel.

The final scenario is the APS scenario which is a combination of the EEC and RE options.

(iv) Mitigation Outlook for 2020

As shown in Figure 3.4, CO_2 emissions under the BAU scenario is expected to grow annually at about 3.72 percent from 2000 until 2020, EEC scenarios at 3.53 percent, RE scenario at 3.49 percent and the APS scenario at 3.2 percent. In 2020, in terms of total CO_2 emissions, the APS scenario will have the least CO_2 emissions at 234,065 Gg, followed by RE scenario at 248,433 Gg, EEC scenario at 251,058 Gg, and BAU scenario at 259,844 Gg.

Table 3.4
Scenarios for the Energy Sector

<table>
<tr><th>SCENARIOS</th><th>ASSUMPTIONS</th></tr>
<tr><td>Energy Efficiency and Conservation (EEC)</td><td>1. Total Electricity Demand in Industrial Sector (INEL)
Potential reduction of electricity demand in industrial sector from the year 2015 until 2020 by 0.8 percent per annum (total of 4.8 percent)

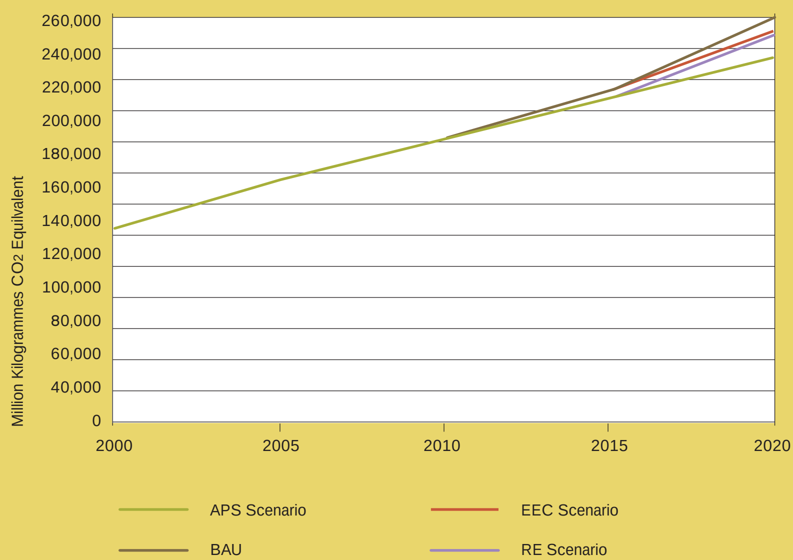
2. Final energy demand in Industrial Sector (INTT)
Potential reduction of final energy demand (electricity + petroleum products + coal + natural gas) in industrial sector by 1.0 percent per annum from 2015 until 2020 (total of 5.0 percent)

3. Final energy demand in Commercial Sector
Potential reduction of electricity demand in commercial sector from the year 2015 until 2020 by 0.8 percent per annum (total of 4.8 percent)</td></tr>
<tr><td>Renewable Energy (RE)</td><td>1. By 2020, Malaysia will be expected to have renewable energy (RE) capacity in power generation. The breakdown of the capacity based on type of fuels are shown below:
<table>
<tr><th></th><th colspan="6">Cumulative Capacity (MW)</th></tr>
<tr><th>Year</th><th>Bio-mass</th><th>Biogas</th><th>Mini-hydro</th><th>Solar PV</th><th>Solid Waste</th><th>Total</th></tr>
<tr><td>2015</td><td>330</td><td>100</td><td>290</td><td>65</td><td>200</td><td>985</td></tr>
<tr><td>2020</td><td>800</td><td>240</td><td>490</td><td>190</td><td>360</td><td>2,080</td></tr>
</table>

2. By 2015, 5 percent of Malaysia’s share of diesel consumption in the transport sector will come from biodiesel.</td></tr>
<tr><td>Total Combination of Assumptions (APS[43])</td><td>APS = EEC + RE</td></tr>
</table>

43 All Plausible Scenario/Alternative Policy Scenario

Figure 3.4
CO2 Emissions Projections by Scenario, 2000 – 2020
Fuel: All Fuels, GHG: All GHGs



Note: The RE and APS scenarios are identical from 2010-2015.

Table 3.5
CO2 Emissions by Scenarios, 2000 – 2020 (Gg)

Year	2000	2005	2010	2015	2020
BAU	125,071	155,306	180,716	212,902	259,844
EEC Scenario	125,071	155,306	180,716	212,902	251,058
RE Scenario	125,071	155,306	180,716	207,447	248,433
APS Scenario	125,071	155,306	180,716	207,447	234,065

3.2.2 LULUCF Sector

In spite of the rapid rate of development as described in Chapter 1, Malaysia continues to be among the most highly forested countries in Southeast Asia and the world. Malaysia currently retains 55 percent of its natural forests.

This has been largely due to the fact that Malaysia, as part of its national forest policy and National Forestry Act, has set aside 14.19 million out of the 33 million hectares of the country as permanent forest reserves. These serve as the core forested areas of the country. Of this forested area, 10.53 million and 3.66 million hectares serve as production and protection forest respectively. A further 1.8 million hectares have been designated as national parks and wildlife sanctuaries, both of which are totally protected so that, in total, 16 million hectares or approximately one half of the total area of the country is under perpetual management as natural forest. There are approximately a quarter of a million hectares that have been dedicated to forest plantations and all remaining forests are designated as stateland forest.

As in many developing countries, economic opportunity is the primary driver of land use change in Malaysia. The conversion of forested land into other land uses usually yields two stages of income; first, the income of the sale of timber from the area and second, the income from the converted land use. In 2009, Malaysia produced 17.56 million tonnes of crude palm oil valued at an average price of RM 2,244.50 per tonne. This translates to an annual earning of RM 8,400 per hectare. In Malaysia oil palm plantations covered approximately 4.69 million hectares as of 2009, but are not classified as forest.

(i) Forests for Mitigation of Climate Change

Studies in Malaysia have shown that a significant amount of carbon is sequestered by existing forested areas and managed land use areas. Furthermore, substantial amounts of carbon are sequestered through reforestation and replanting programmes, as well as suburban and urban tree planting. As a result of more comprehensive data capture, the current estimated annual carbon uptake of forests and other woody biomass in Malaysia is significantly higher than results estimated from the INC. As noted in Chapter 2, national average sequestration rates by forests in Malaysia ranged between 240.5 Mt CO_2 eq in 2005 to 249.8 Mt CO_2 eq in 2000.

(ii) Approaches to Mitigation in the Forestry Sector

Climate change mitigation in the forestry sector may be accomplished through two broad approaches. The first approach involves reducing the rate of forestry-related GHG emissions to the environment. Emissions reductions in the forestry sector can be accomplished either through harvesting fewer trees and converting less forested land to other land uses, or, alternatively, by harvesting timber or converting land in ways that result in fewer emissions of green house gases to the atmosphere. In the forestry sector, emissions are associated primarily with timber harvesting. Sources of emissions include the actual harvesting event, the efficiency of log utilization and physical damage to surrounding trees, under storey plants, and oxidative loss of soil carbon. Therefore barring the complete cessation of harvesting, the most intuitive method of reducing emissions, is simply to harvest fewer trees and to harvest a given area less frequently. The second broad approach takes advantage of the unique ability of living green plants to remove carbon dioxide from the atmosphere, sequester the carbon in the form of lignin and cellulose-based materials, and release oxygen back to the atmosphere. Using this approach, forests and green spaces can also be used to mitigate climate change and global warming through the sequestration of CO_2. This carbon is stored in the form of wood and other stable organic compounds such as humus or other soil carbon and not released to the atmosphere in the near-term.

Potential areas for the establishment of these new forests have been studied and some promising areas identified include abandoned mined lands, low-productivity coastal dune soils known as ‘bris’ soils, and other ‘problem’ soils such as lateritic soils. Besides restoring forests in non-forested areas, efforts are also being made to increase the carbon stocks in existing forest stands. Secondary forest stands as well as production forests can be enriched through planting to increase carbon stocks.

Other avenues for the sequestration of carbon dioxide include the use of non-forest trees such as roadside, border and fence-row plantings and even suburban and urban community-based arboriculture. In addition, Malaysia needs to further explore the potential of novel approaches to increase carbon sequestration capacity, including the use of green roof gardens.

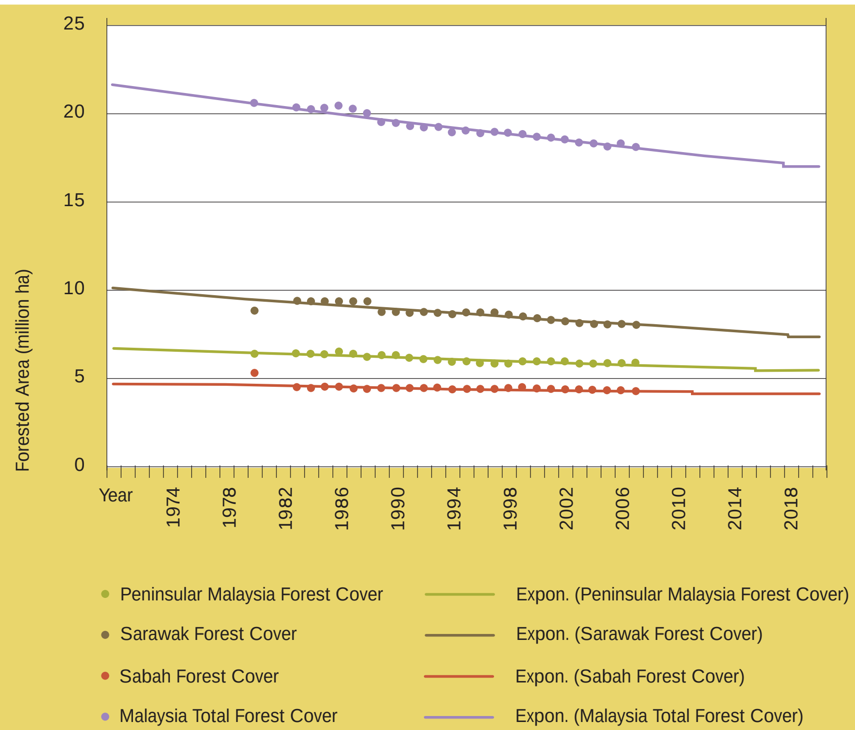
(iii) Developing LULUCF Scenarios

a. Reducing the Rate of Forest Conversion

As mentioned earlier, Malaysia maintains a core area of permanently forested areas for conservation as well as for the sustainable production of timber. Because of the land use change restrictions within this core area, any change in forest cover amounting to deforestation would most likely occur on 'State Land', which, in many cases, consists of degraded forests that are low in carbon stocks.

The historic rate of forest conversion in each of the three geographic regions of Malaysia, Peninsular Malaysia, Sabah, and Sarawak, was used to project the national change in forest cover, and its associated carbon emissions between 2008 and 2020. Figure 3.5 shows the data and the resulting projections that would represent the 'business as usual' or baseline scenario. In the baseline scenario, a total area of 1.3 million hectares of forested land stands to be converted through the year 2020. At this baseline deforestation rate, forest cover in Malaysia would be reduced to 17.1 million hectares or 51.8% of the total land area of the country by 2020, a level that is precariously close to the minimum forest cover pledge of 50% that Malaysia first made in Rio in 1992 and reiterated in Copenhagen

Figure 3.5
Actual and Projected Forest Cover for Peninsular Malaysia, Sarawak and Sabah through 2020



in 2009. As alternatives, two mitigation scenarios were projected representing a one percent and five percent reduction in the rate of forest conversion between 2011 and 2020. The results of the projections, including the baseline and mitigation scenarios, together with the opportunity costs and potential returns from carbon payments, are presented in Table 3.6.

Carbon density in different forest types varies widely and may range from 150 tonnes of biomass per hectare or less in young or sparse forests to 400 tonnes per hectare or more in intact old growth primary forest. Highly degraded forest and agricultural land may have an even lower biomass in the neighbourhood of 60 tonnes per hectare. In line with the greater likelihood that sparse or highly degraded areas of forest are converted, a biomass of 140 tonnes per hectare (70 tonnes of carbon per hectare) is used in the calculations. However, conserving intact forest with high biomass (about 150 tonnes of carbon per hectare) would significantly increase carbon earnings.

In the same way, the price of carbon credits also varies widely and may range from a low of less than USD 3.00 a tonne CO_2 eq to a high in excess of USD 40.00 a tonne, as a function of the respective market demand for the various credit and project types supplied to the market. In this assessment, in view of the fact that market carbon prices for forestry-based activities ranges from USD 2.90 to USD 7.30, a conservative price of USD 5.00 (RM 16) a tonne is assumed.

Oil palm plantation establishment is the most common cause of land conversion from forests to other land use. Opportunity costs are estimated based on potential earnings from converting forests to oil palm plantations. These earnings would begin to accrue five years after planting, and would take into account the cost of establishing the plantation. As palm oil prices vary on the market, the earnings per hectare vary considerably. For this comparison, each hectare of oil palms is estimated to yield RM 8,400 per year while the cost of establishing the plantation is estimated at RM 10,000 per hectare.

The cost of reducing forest conversion through 2020 is estimated by comparing opportunity costs (adjusted for oil palm plantation establishment) to potential income from carbon payments based solely on preventing the emission of the carbon content stored in the forest. Valuation of other ecosystem services is not included in the estimates.

Table 3.6 shows that the opportunity cost for the conversion of degraded forest exceeds the carbon offset value, making forest conversion more profitable than retention of forests under either the 1% or the 5% reduction scenario. However, protection of intact forests would yield a higher carbon offset value per hectare, making conservation a more attractive option. In Table 3.6 the deficits represent the amounts needed in addition to the carbon offset values to match the opportunity costs of converting degraded forests.

b. Establishing New Forest Plantation Growing Stocks

Establishing new forest plantations and initiating large-scale urban tree-plantings are

Table 3.6
Potential opportunity costs relative to potential carbon credit revenue for a 1% and 5% reduction in baseline deforestation between 2011 and 2020

Forest conversion Reduction (%)	Avoided deforestation (ha)	Net Opportunity costs (million RM)	Carbon revenue (million RM)	Deficit (million RM)	Avoided emissions (Mt CO_2 eq)
1% Reduction	13,000	99.3	53.4	45.9	3.34
5% Reduction	65,000	496.6	266.9	229.7	16.68

among the simplest and most direct methods of generating new and additional carbon stocks to mitigate emissions. Embarking on an aggressive plantation programme between now and 2020 will ensure that there are large tracts of actively growing plantation stock that will continue to sequester atmospheric carbon. However, tree plantations vary widely in terms of the amount of carbon sequestered. The level of sequestration is directly proportional to the number of trees or the land area to be planted. It is also a function of the species or species mix selected for planting, as well as the environmental conditions. Clear methodologies exist to quantify planted carbon stocks. It is important to note that carbon density of the land prior to the establishment of the plantation needs to be accounted for in the implementation of this activity. This includes emissions due to land clearing prior to tree planting. It is therefore assumed that any new plantation is established on non forested areas or on areas with minimal existing carbon stocks. For this assessment, carbon stocks are projected to accumulate at a conservative average rate of 3 tonnes per hectare per year.

By the same rationale, the cost of tree planting ranges widely depending on the species planted and the level of tending required. Depending on the species selected, the remoteness of the location and the site preparation required, plantation establishment can range from RM 5,000 per hectare for low cost, low maintenance species to more than RM 150 per tree for high-value ornamental species. In this scenario, based on current industry statistics, the cost of plantation development is estimated at RM 5,000 per hectare. Table 3.7 below compares the opportunity costs with the projected carbon revenue for plantation establishment, taking into account the significant costs of establishing forest plantations. As with the forest cover loss reduction scenario above, the deficits show that potential carbon revenues do not even cover the cost of plantation establishment, much less the opportunity costs of using the land for other non-forest uses.

c. Reducing the Rate of Harvesting for Wood-based Products

It is also possible to reduce GHG emissions from forests by reducing the volume of wood removed for the manufacture of wood-based products. However, the wood-based manufacturing sector, which includes sawn timber, plywood, fibre-board, veneer and mouldings, together with the entire furniture manufacturing sector, is an extremely high-value product stream that will be seriously impacted by any reduction in the supply of legally sourced timber. As such, attempting emissions reductions in this sector by reducing the volume of wood currently extracted from forests would be extremely costly.

(iv) Conclusion

The projections show that reducing the rate of forest conversion by as little as 5 percent has the potential to reduce emissions by as much as 16.68 million tonnes CO_2 eq

Table 3.7
Potential opportunity costs relative to potential carbon credit revenue for four rates of plantation establishment between 2011 and 2020 taking into account the cost of plantation establishment

Planting rate (Hectares/yr)	Total planted By 2010 (ha)	Net opportunity costs (million RM)	Establish-ment (million RM)	Carbon revenue (million RM)	Deficit (million RM)	Sequestra-tion (Mt CO_2 eq)
50,000	500,000	3,820	2,500	457.6	5,862.4	28.6
100,000	1,000,000	7,640	5,000	915.2	11,724.8	57.2
150,000	1,500,000	11,460	7,500	1,372.8	17,587.2	85.8
200,000	2,000,000	15,280	10,000	1,830.4	23,449.6	114.4

between now and 2020 at a marginal cost[44] of RM 13.77 a tonne. A far more modest 1 percent reduction could cut emissions by approximately 3.34 million tonnes at a similar marginal cost. This mitigation pathway has the lowest cost in that the deficits are lowest. However, mitigation cost still exceeds the carbon offset price on the markets. Carbon price in excess of RM 30 per tonne would approach the amount necessary.

The establishment of new tree plantations at a low rate of 50,000 ha a year would sequester up to 28.6 million tonnes of CO_2 between now and 2020. A more ambitious planting of 200,000 ha a year would greatly speed the sequestration process. This mitigation option has much higher marginal cost amounting to RM 205 per tonne CO_2 eq per ha.

On the other hand, reducing the harvesting of timber to a level needed to produce the major wood-based commodities would be the least feasible option because of the high value of these wood-based commodities. From a cost perspective, priority should therefore be given to protecting existing forest cover and establishing new forest plantations over reducing the harvest of timber from production forest.

From an economic standpoint, at the current carbon price point, assumed to be effectively RM 16 per tonne CO_2 eq, forest conservation loses out to more intensive forest use for timber and wood-based commodities, as well as high-intensity use of available land for the production of high-value cash crops. The carbon price point stemming from market-based emissions offset programmes such as the CDM and Reducing Emissions from Deforestation and Forest Degradation (REDD+) needs to be slightly higher to make forest conservation feasible. For new plantation establishment and reduction of timber harvesting for high-value wood-based commodities, a much higher carbon price is needed.

To bridge the gap between market values for carbon and the cost of forest protection, several initiatives are under development to assess and certify land use management practices that are friendly, not just to climate, but to community livelihoods, biodiversity, water supply and other ecosystem services. These methodologies do not, by themselves, ascribe monetary value to ecosystem services in the form of tradable or fungible credits. Nevertheless, these initiatives may provide forest managers with some basis for negotiating more favourable prices for the protection and preservation not just of the forest carbon resources, but also the forests capacity for the provision of other ecosystem services such as water, biodiversity and recreation as an interim measure until the true worth of the suite of products and services provided by forests is finally determined.

3.2.3 Waste Sector

As GHG emissions from solid waste is a key source, the following assessment is focused on potential mitigation from solid waste. GHGs are emitted when organic waste is broken down or degraded by microorganism actions in a series of stages in the disposal sites. Mitigation strategies for reduction of GHGs from solid wastes therefore focus only on the organic portions of solid wastes, which can be achieved in three stages of solid waste management, namely:

a. Waste generation: Reduction of organic waste generation so that the organic wastes that need to be treated or disposed are minimised.
b. Waste treatment: Proper treatment/ recycling of organic waste to minimise the amount disposed.
c. Waste disposal: Proper landfill management to ensure that GHG emissions from the site are properly captured for flaring or recovery.

The projected gross annual CH_4 generation in Malaysia for year 2020 is 2,037 Gg[45], based on the assumption that there is no policy and

44 Marginal cost is determined by dividing the scenario deficit by the emissions avoided or CO_2 sequestered.

45 This figure is based on the expected population in 2020 as noted in the NSP of 27.7 million in accordance with earlier projections. However the expected population has since been revised upwards to 32.8 million. Calculations revisions will be made in future assessments.

strategy in place for mitigation in year 2020. The following are some of the measures that need to be implemented in order to reduce emissions from the whole sector:

- Mandatory source separation system
- Composting food wastes/green wastes
- Upgrading of disposal sites
- Construction of new sanitary landfills
- Landfill gas CDM projects
- Waste to energy facilities
- Thermal treatment plants

(i) Mitigation Assessment

The following analysis shows potential GHG mitigation based on achieving recycling rate targets and acquiring adequate technology. As the assessment is based on the National Strategic Plan for Solid Waste Management (NSP), it does not include the GHG emissions reduction potential from Sabah and Sarawak. Furthermore, the main source of waste generation is still expected from Peninsular Malaysia given the higher population and growth rate of urban population.

Scenario analysis was conducted based on the Government's target to achieve a 22 percent recycling rate by 2020 (Scenario 1), as well as successfully operating several facilities using alternative technologies such as material recovery facilities (MRFs) and thermal treatment plants (Scenario 2). In both instances, it is assumed that the landfills where the residue waste eventually ends up are fitted with methane recovery facilities with an anticipated 25% recovery rate. The potential GHG reduction results are presented in Table 3.8 which shows a potential CH_4 emissions reduction of as much as 57.7 percent.

It is to be noted that the materials targeted for recycling as described in the NSP focus only on paper, plastic, glass and metals. No target has been set for recycling organic food waste. However, when implemented, the mandatory source separation as stipulated in the new Solid Waste and Public Cleansing Management Act 2007 could result in possible organic waste composting.

Various efforts on recycling organic food wastes and green wastes have been observed on a small scale at the moment. These recycling efforts have great potential to be expanded if further support is provided such as incentives on technology transfer and confirmed demand for the compost produced. Some of these efforts are noted in Table 3.9.

Based on the above, there are substantial benefits to be gained from a comprehensive waste management programme that includes reduction of organic wastes reaching landfills. Measures in terms of access to and the acquisition of appropriate technologies as well as educating the public would enable the reaping of the emission reduction potential that the waste sector offers.

Table 3.8
Reduction Targets and Expected CH_4 Emissions Reduction (2020)

Scenario	CH_4 emission reduction	Projection of CH_4 emission after reduction	Target of 25% CH_4 Recovery	Emission After 25% CH_4 Recovery	Emission After 25% CH_4 Recovery	Emission Reduction Achieved
	Unit in Gg CH_4				Gg CO_2 eq	%
Baseline Scenario (2020)	0.0	2,037.4	-	2,037.4	42,785.4	-
Scenario 1 (2020)	13.8	2,023.6	505.9	1,517.7	31,871.7	25.5
Scenario 2 (2020)	888.3	1,149.1	287.3	861.8	18,097.8	57.7

Table 3.9
Initiatives on Food Wastes and Green Wastes Recycling

Initiative	Capacity of Waste Processed
Composting of food wastes from hawker centres by the Subang Jaya Municipal Council (MPSJ) using in-vessel composting technology	500 kg/day ~180 tonnes/year
Composting of green market wastes at Bandar Bukit Puchong using windrow method with the use of effective microorganisms	1.7 tonnes/day ~600 tonnes/year
Composting of community food waste and green waste by the local community in Seberang Prai	40 kg/day ~10 tonnes/year
Promotion of home composting of organic food waste by a NGO in Petaling Jaya	Not available
Promotion of home-made garbage enzyme from kitchen waste throughout the country to reduce waste for disposal	Not available
In-situ treatment of food waste generated by several private entities such as hotels, markets, hospitals and industries through various self-initiatives such as composting, in-vessel composting or carbonization.	100~250 kg/day 35~90 tonnes/year

3.2.4 Agriculture Sector

CH_4 from rice production is the main source of emissions for this sector. Fertiliser usage and livestock management also contribute significant and growing emissions. The future emissions from rice cultivation will probably increase slightly due to production intensity and the small increase in new areas of rice cultivation. Additionally, future emissions from the livestock sector will potentially increase parallel with the government's plan to increase cattle livestock production from the present 15 percent to 40 percent self sufficiency or an increase of about 1.5 million cattle.

(i) Mitigation Options in the Agriculture Sector

Emissions reductions in the agriculture sector can be achieved through irrigated rice water management, nitrogen fertiliser management and manure management.

a. Irrigated rice water management

Most of the CH_4 emissions from rice cultivation (1,300 Gg CO_2 eq or 70 percent) were from continuously flooded irrigated rice areas. Draining paddy fields will substantially reduce CH_4 emissions. For example, a single mid-season drainage will reduce emissions by 50 percent, and multiple drainage will reduce emissions by 80 percent. Alternatively water can be drained out earlier once the crop is mature. During off-rice seasons or periods of inter-cropping, water logging must be avoided and the soil must be kept as dry as possible. Water management infrastructures need to be tailored towards alternating irrigating and draining once or several times during the growing and fallow seasons. With the proper set up of water control infrastructures and good water management especially in the main granary areas, GHG emissions from rice cultivation can be reduced by about 30 percent by 2015 compared to BAU.

b. Nitrogenous fertiliser management

N_2O emissions from agricultural soil originate mainly from the added nitrogenous fertilisers contributing about 30 percent of total emissions for the agriculture sector. Emissions can be thus reduced by using alternative natural sources of nitrogen especially bio-fertilisers or soil microbes. Various types of microbes can fix atmospheric nitrogen and make it available to plants.

The use of bio-fertilisers will reduce the heavy reliance on chemical fertilisers. In the long term it can also increase the carbon sequestered in soil thus increasing the soil organic matter. Undertaking these measures can result in a reduction of 5-10 percent N_2O emissions by 2015 compared to BAU with greater reductions expected by 2030.

c. Manure management

GHG emissions will increase proportionally to the number of livestock kept. Technologies on reducing emissions from enteric fermentation are presently not economically feasible especially when Malaysia is importing most of its concentrate feed.

Collecting and storing livestock manure in lagoons or pools releases CH_4 from the anaerobic decomposition process. Aerobic composting of the manure can suppress CH_4 emissions. The addition of digester microbes can speed-up the decomposition process and reduce odour. Further addition of beneficial microbes e.g. the nitrogen fixers and P-Solubilizers can turn the manure into more valuable bio-fertilisers.

The use of composted manure in agricultural soils should be encouraged as it is a food source for soil microbes. Interactions between the manure and the microbes will increase the content of organic matter making the soil more fertile and sustainable for crop production while at the same time reducing GHG emissions both from manure decomposition and fertiliser usage.

With the increase in prices of chemical fertilisers, the demand for composted manure is increasing, making it a good opportunity for farmers to earn some extra income. Adoption of this technology is easy and reduction of CH_4 emissions from cattle manure can be reduced by about 4 percent by 2015.

The next mitigation potential is biogas production from livestock such as beef feedlots and dairy farms as well as piggery wastewater. BAU practice in managing manure wastewater is to use open lagoons which generate GHG emissions. However with proper facilities, the biogas or methane can be captured thereby reducing GHG emissions. The captured methane can also be used as an energy source, further reducing GHG emissions from fossil fuel generated energy.

3.2.5 Industrial Processes

In Malaysia, industrial processes are among the largest GHG emitters because of their high usage of fossil fuel for combustion. Apart from that, their manufacturing processes also account for some emissions. The bulk of the emissions come from the cement manufacturing industry. Hence the cement manufacturing industry is the main focus for mitigation in this sector. There were some N_2O emissions from the production of nitric acid in the country, however production had stopped by the year 2005.

(i) Changing the blend or raw material mix in cement production

Generally mitigation measures in industries are more associated with controlling air pollutants rather than GHG emissions. However, certain industries, have already embarked on developing or even developed techniques to reduce CO_2 emissions.

The production of cement is energy intensive and results in energy related CO_2 emissions and CO_2 emissions due to calcinations (heating of limestone to drive off carbon dioxide). Cement is produced out of clinker. Decreasing the share of clinker in cement by adding additives like fly ash, gypsum, slag etc. allows for reducing process-related emissions due to calcinations. Blending also reduces energy-related emissions in the clinker production.

Another way to reduce calcinations-related emissions in cement production is to substitute raw material for clinker production by non-carbonated calcium sources. In this case, the share of clinker in the cement remains unchanged but CO_2 emissions from clinker production decreases.

Based on a CDM project, the cement industry in Malaysia can be expected to reduce its GHG emissions by 10%.

3.3 Cross Sectoral Analysis

The cross-sectoral analysis identified how one sector can potentially impact or support another. However, no detailed assessment on cost of impact and support, deployment of low-cost technology, limitations or incentives for innovation, are included here. The analysis highlights the need to take a holistic approach in considering mitigation options. Furthermore, it underscores the need for proper planning to harness maximum benefits from mitigation measures. The following are some preliminary examples:

- Using by-products from the agriculture and waste sectors such as biomass and biogas to generate RE. The energy generated could in turn be used in these sectors for example farm usage or leachate treatment plant usage.
- Increasing tree cover could help the other sectors e.g. the waste sector, through planting trees on closed dumpsites and landfills. This will also help to green the landscape.
- Forest ecosystems are a potential source of nitrogen-fixing microbes which could potentially be used in the aerobic rice industry. In addition, urban forests or parks will help reduce heat island effects, thus reducing the need for air conditioning.
- Using solid waste compost as fertilisers will be beneficial for the agriculture sector.

3.4 Towards Achieving the 2020 Emission Reduction Scenario

As mentioned in the introduction of the chapter, Malaysia voluntarily aspires to reduce GHG emissions intensity of GDP by up to 40% of 2005 levels by 2020. This translates into emitting only about 60 percent of the 2005 GHG emissions in the production of each unit of GDP.

The emissions intensity of GDP in 2005 based on estimated emissions and GDP was 0.62 tonnes CO_2 eq/thousand RM. The aspiration for 2020 is an emissions intensity of 0.37 tonnes CO_2 eq/thousand RM.

On the assumption that Malaysia successfully progresses on the path of projected development, GDP in 2020 is expected to be RM 906.640 billion. Total emissions would have to be limited to about 335 million tonnes CO_2 eq.

For the energy sector, achieving the APS scenario would result in reducing total emissions from 260 million tonnes to about 234 million tonnes CO_2 eq. In the waste sector, the reduction could be lowered to 18 million tonnes from 43 million tonnes CO_2 eq. Without mitigatory measures, these two sectors alone would contribute about 303 million tonnes CO_2 eq. (90% of the maximum total based on the projected GDP in 2020). Additionally, forest management and conservation provides significant benefits in terms of avoided emissions and enhanced sequestration.

Furthermore, emissions reduction potentials in the other activities identified in Table 3.1 should be studied with a view to taking measures to implement these activities.

3.5 Conclusion

As mentioned before, growth is important for Malaysia to achieve the developmental goals of total poverty eradication, socio economic equity and transformation into a high income nation. In order to develop sustainably, Malaysia has adopted certain polices. The analysis above shows that GHG emissions reductions can also be achieved with the implementation of these policies. Timely access to appropriate technology and finances are necessary to ensure the overall achievement of the lower emissions per unit GDP scenario. This is especially so in the energy and waste sectors. If mitigation measures are to be financed by carbon offset mechanisms, then the price for carbon should also adequately reflect the opportunity cost of avoided emissions or enhanced sequestration.

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Chapter 4

VULNERABILITY & ADAPTATION ASSESSMENT

CHAPTER 4: VULNERABILITY & ADAPTATION ASSESSMENT

4.1 Background

Adapting to climate and the environment is a necessary response for human survival and this has influenced the evolution of society and its economy into what it is today. The present levels of progress by mankind and development of all sectors of the economy were achieved in a relatively stable climate over thousands of years. The climate is now changing and impacts every aspect of life. All the achievements to date and plans for the future face the threat of anthropogenic induced climate change. As the change is already occurring, there is an urgent need to prepare and adapt to the present and future changes to ensure the continued progress and well-being of society and nations.

4.2 Advances since the Initial National Communication (INC)

Based on the recommendations of the INC, Malaysia has implemented several programmes towards improving its climate change impact, vulnerability and adaptation assessments. Those recommendations were wide ranging and systematic actions taken to address those recommendations have begun to show positive results.

The lack of downscaled climate projections was one of the main constraints to spatial details in quantitative vulnerability and adaptation assessments. Consequently, a significant achievement was the development of a dynamic downscaled (9km resolution) model called the 'Regional Hydro-Climate Model for Peninsular Malaysia (RegHCM-PM)' to generate climate and hydrological projections. A similar model for Sabah and Sarawak is being developed and is due to be completed by the end of 2010. Another projection model, 'Providing Regional Climates for Impacts Studies (PRECIS)', developed by the Hadley Centre for Climate Prediction and Research, UK Meteorological Office (Hadley Centre) has also been used for climate projections. However while it can be downscaled to 25 km resolution, due to computing resource limitations, it was only downscaled to 50 km resolution. The downscaling of these two models are significant milestones in facilitating more detailed quantitative climate change impact and vulnerability assessments towards developing and selecting more appropriate adaptation options.

In the water sector, efforts to incorporate integrated approaches to water management through the introduction of Integrated Water Resources Management (IWRM) plans and its implementation have also strengthened Malaysia's ability to deal with floods and droughts. Additionally there have also been some infrastructure improvements such as the 'Storm Water Management and Road Tunnel' (SMART) which help to address urban flooding in Kuala Lumpur city and the structural upgrade of Timah Tasoh Dam in the state of Perlis to increase storage capacity to alleviate water shortages.

In agriculture, several drought tolerant varieties of rice, rubber, oil palm and cocoa are under development. Research on aerobic rice that consumes less water has also been initiated.

In the forestry sector, measures to enhance the National Seed Bank collections have been undertaken to ensure the survival of genetic stock. Additionally, protected forest areas and forest state parks have been expanded which is expected to enhance natural adaptation processes of forests.

Efforts are being taken to ensure sustainable development and management of coastal areas especially to cope with impacts of climate variability and change including sea level rise. The implementation of the Integrated Shoreline Management Plans (ISMP) by local authorities has already started in selected coastal areas of the country.

In the Health Sector, larval and insecticide controls are already in place as part of the Vector-borne Diseases Control Programme. Standard Operating Procedures for emergency and disaster management are already incorporated at all levels of the national health infrastructure.

4.3 Approaches, Methodology and Tools Applied

The outputs of the downscaled regional climate models provided inputs for analysis and modelling for the different sectors. The analysis includes advanced modelling in the water resources, agriculture and public health sectors, establishment of indices in the coastal resources sector and use of data from experimental plots in the forestry sector to the reliance on more fundamental observed data and literature review in the biodiversity sector. Surveys and workshop discussions in the energy and transport sector have also been undertaken. The socio-economic analysis, whilst still at its preliminary stages, has adopted an iterative approach that is intended to proceed with micro assessments at the regional and sectoral level thus providing inputs to cross-sectoral macro level assessments.

To summarize, while in most sectors reliance has been placed largely on already available data and information, studies and analysis specifically driven by climate change have also been attempted.

4.4 Observed Climate Change

The range of annual mean surface temperature for the country as a whole is about 26°C to 28°C. Based on 40 years of record (1969-2009) the rate of mean surface temperature increase for Malaysia ranges from 0.6°C to 1.2°C per 50 years.

Observed rainfall intensity from 2000 to 2007 at the DID Rainfall Station, Ampang exceeded the amount observed in 1971 to 1980, which previously was the highest recorded. Annual maximum rainfall intensity for 1 hour and 3 hour durations (2000-2007) recorded an increase by 17 percent to 112 mm/hour and by 29 percent to 133 mm/hour respectively compared to the 1970s values.

Data on sea level rise collected over a 20 year period (1986-2006) from an area at the southern tip of the Peninsula, (Tanjung Piai in Johor), showed a rate of increase of 1.3 mm/year.

4.5 Projected Climate Change

The RegHCM-PM model was used to produce hydroclimate projections up to the year 2050 whilst the PRECIS model was used to produce climate change scenarios up to 2099. Based on both these models, surface temperature is projected to rise while rainfall and river flows are projected to experience greater fluctuation. This trend appears to continue beyond 2050.

The projections based on the medium range emission scenario indicate a 1.5°C to 2.0°C increase in surface air temperature by 2050. There appears to be no significant change in the annual wet and dry cycles but there could be extremes within and between these cycles in terms of maximum and minimum rainfalls. The frequency of extreme weather is also projected to increase.

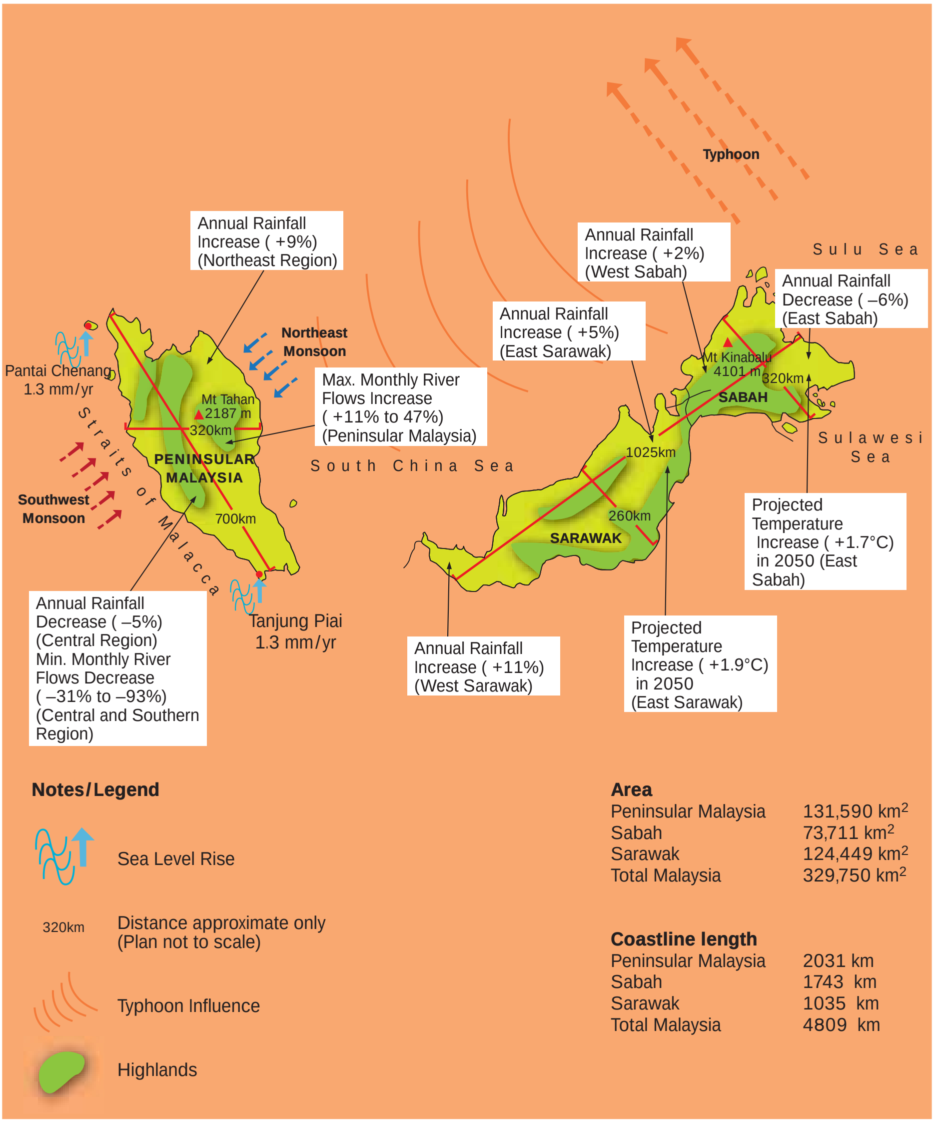
Based on the RegHCM-PM projections, some indicative changes in rainfall patterns projected for Peninsular Malaysia by 2050 are as follows:

- The northeast region shows the greatest projected increase in average annual rainfall at 9 percent.
- The central region shows the greatest projected reduction in average annual rainfall at 5 percent.
- The northeast region is projected to experience the greatest increase in maximum monthly rainfall, an increase of 50 percent.

For Sabah and Sarawak, regional rainfall projection has been obtained using the PRECIS regional climate model only. The baseline period considered is from 1961-1990. The changes in projected rainfall by 2050 are as follows:

- The eastern part of Sabah shows the only projected reduction in average annual rainfall at around -6 percent.
- The western part of Sabah shows projected increase in average annual rainfall at around 2 percent.
- The eastern part of Sarawak shows projected increase in average annual rainfall at around 5 percent.

Figure 4.1
Climatic Patterns and Projected Changes



- The average annual rainfall in the western part of Sarawak is projected to increase by about 11 percent.

These projected increases in rainfall could lead to river flow increases of between 11 percent and 47 percent for Peninsular Malaysia with low flow reductions ranging from 31 percent to 93 percent for the central and southern regions. A study has been initiated to project sea-level rise in Malaysia based on global sealevel rise projections.

4.6 Key Sectors and Scope of the V&A Assessment

For the NC2, climate change impact and vulnerability were assessed for seven sectors, Water Resources, Agriculture, Biodiversity, Forestry, Coastal and Marine

Resources, Energy, and Public Health. Thereafter, adaptation options were considered and recommended. For each sector, vulnerability assessments were conducted on their respective sub-sectors, activities and components and adaptation options developed to address those deemed vulnerable. A cross-sector analysis followed these. Gaps and uncertainties as well as capacity building requirements were also identified.

4.7 Impacts and Vulnerability

Based on the climate change projections of the RegHCM-PM and PRECIS models together with related studies, impacts on each sector and associated vulnerabilities were assessed as summarised below:

4.7.1 Water Resources

Studies indicate that water resources are generally adequate over the projected period of 2025-2050. However, urban areas can be expected to experience disruption of water supply during extreme drought events. Lower rainfall could lead to water shortages for irrigation, domestic and industrial use and also affect river water quality. Water shortages would require more draw-down from water supply reservoirs, which in turn could deplete water reserves in reservoirs. Climate change impacts on water resources are also likely to have the following effects on irrigation water supply as well as the incidence of floods and severe erosion.

(i) Irrigation Water Supply

The Muda Agriculture Development Authority (MADA) granary area is projected to experience significant water deficits that would affect 10 out of 40 planting seasons. The prolonged deficit of irrigation water may warrant the cancellation of paddy planting in either some parts, or at worst, all of the MADA area. During other periods, excess water, which is expected for about 76 percent of the 240 months studied, could impact crop yields.

While the number of projected water deficit months for the Barat Laut Selangor Irrigation Scheme is fewer than the MADA scheme, one of the deficit events is expected to be severe enough to disrupt planting in some parts.

The Kemubu Agriculture Development Authority (KADA) granary area is not expected to experience any serious deficits. However, there are indications of extreme surplus of up to 5,438 MCM which may increase the probability of flooding and crop damage in some areas.

The NAHRIM 2009[46] study indicates that based on the capacities of existing facilities (i.e. Klang Gates Dam, Batu Dam, Sg. Selangor Dam, Tinggi Dam and downstream catchment between Sg. Selangor Dam to Batang Berjuntai Intake Point, excluding the Pahang-Selangor water transfer project), 28 (nearly 12%) out of the total 240 months are projected to face water supply deficit situations. These monthly water deficits range from 3 MCM to 214 MCM. The highest surplus could be as high as 2,137 MCM.

These estimates were based on demands from population that is increasing from nearly 5 million in 2010 to nearly 7 million in 2050. The estimates are also based on the assumption that per capita domestic consumption increases from 300 in 2010 to 330 in 2050 litres/capita/day and Non-Revenue Water (NRW) increases from 185 in 2010 to 207 litres/capita/day in 2050. Flood aspects are not considered and these may affect some of the facilities.

(ii) Floods and Erosion

Higher rainfall and extreme flows increase the severity of floods in affected areas whilst increasing the likelihood of floods in presently unaffected areas. This could lead to failure of water control structures including dams, barrages and bunds. Soil saturation due to prolonged rainfall will cause more frequent and severe landslides. In addition, high rainfall intensity will accelerate soil erosion and cause soil degradation, scouring of drainage structures and sedimentation in rivers and reservoirs.

46 Preliminary impact assessment of climate change on irrigation and water supply scenario for selected areas in Malaysia, July 2009

Projections relating to maximum and minimum monthly rainfall therefore require special attention as they reveal the potential severity of droughts and floods. These in turn could influence policy decisions and enhance management of available water resources.

The above assessments consider impacts on consumptive uses of water resources. Impacts are also anticipated in the non-consumptive use of this critical resource such as environmental services (river flows to sustain life within and along rivers), power-generation and recreation (tourism). Future studies should consider the vulnerabilities of non-consumptive uses of water resources to climate change.

The current study evaluates the impact on the three schemes without taking into account competing water needs by other consumers. Nevertheless these impacts should be taken into account in management and adaptation planning.

4.7.2 Agriculture

Available literature show that temperature has an inverse relationship with yield at the upper range of the optimum growth curve, i.e. higher temperatures should lead to a corresponding decrease in yields. However, since the temperature of most planted areas is already in the optimum range, slight fluctuation in temperature would most likely not affect yields. On the other hand, rainfall variability is the major limiting factor to the productivity of many crops including the oil palm, a major economic crop for Malaysia.

(i) Oil Palm

The optimum annual temperature for oil palm production is 22°C–32°C with a mean annual evenly distributed rainfall of 2,000–3,500 mm. Oil palm yields could decrease by approximately 30 percent should temperatures increase 2°C above optimum levels and rainfall decrease by 10 percent.

(ii) Rice

The optimum daily temperature for rice cultivation is between 24°C–34°C, while the optimum rainfall is more than 2,000 mm per year. An increase in daily temperature above 34°C will reduce potential yields. However, crop modelling simulations using DSSAT 4.1 for the MADA area showed that a temperature increase of 2°C above the threshold temperature will reduce rice yield by as much as 13 percent. On the other hand, the occurrence of floods (15 percent increase in seasonal rainfall) and droughts (15 percent decrease in seasonal rainfall) early in the growing season could decrease yields by as much as 80 percent.

The quality of agricultural produce could also deteriorate due to adverse growing conditions. Crop vulnerability is dependent on the growth stage of crop growth in relation to the climate.

(iii) Rubber

The optimum annual temperature for rubber production is 23°C–30°C with a mean annual rainfall of 1,500–2,500 mm. An increase in annual temperatures above 30°C coupled with a reduction in rainfall below 1,500mm will retard growth and prolong immaturity resulting in up to a 10 percent reduction in yields based on studies. Additionally, an increase in the number of rainy days will interfere with tapping activities.

(iv) Cocoa

The optimum annual temperature for cocoa production is 25°C – 32°C with a mean annual rainfall of 1,500–2,000 mm. The projected increase of 2°C is still within the optimum temperature range and is not expected to cause any significant reduction in cocoa production. Under drought conditions where annual rainfall is below 1,500mm production would be drastically reduced. An annual rainfall exceeding 2,500 mm will reduce yields due to higher fungus incidence.

4.7.3 Forestry & Biodiversity

(i) Mangrove Forest

In all areas, increased rainfall could result in waterlogged soils and soil nutrient leaching that could lead to tree mortality. Mangrove forests along the low-lying coastlines are vulnerable to sea level rise. This vulnerability could be exacerbated by the projected temperature rise and changes in rainfall patterns.

(ii) Montane Forests

An increase in average local temperature of 1-2ºC is equivalent to an upward shifting of climatic conditions of about 150 to 300 m in the montane environment. This would also mean that as ambient temperatures increase, plants and animals in these margins will need to shift upwards to remain in surroundings of the same temperature, if they are to survive in these montane habitats. In addition, if these plants and animals remain at the original elevations, species from lower elevations will move upwards and encroach into their range, competing for the same resources. Species specializing in the higher elevations will, more often than not, be replaced by these invading species from lower elevations.

The summary shown in Table 4.1 indicates that 1,596 plant species in Peninsular Malaysia may be vulnerable to climate change. This represents about 19 percent of the flora of Peninsular Malaysia.

(iii) Biodiversity

Malaysia has 2,251 species of vertebrates (Table 4.2), birds being the most diverse. For inland vertebrates (including turtles that breed in Malaysian shores), the species that may be vulnerable to climate change were determined by examining existing literature. The selection is based on their exclusive dependence to montane or coastal habitats for their survival. In summary 16 mammal species, 43 bird species, 14 reptile species, 28 amphibian species and 17 fish species are restricted in either mountain or coastal areas in Peninsular Malaysia that may be vulnerable to climate change.

Table 4.1
Summary of Vulnerable Species that may be Impacted by Climate Change in Peninsular Malaysia

Habitats	Families	Genera	Species	Endemics (percentage of number from the habitat)
Montane and higher elevation forests	137	460	1,349	573 (42.4%)
Mangrove and coastal species	72	183	247	15 (6.1%)
Total			1,596	

Table 4.2
Summary of Vertebrates that may be Vulnerable to Climate Change in Peninsular Malaysia

	Total in Malaysia	Montane Species	Coastal Species	Vulnerable Species	Vulnerable Species (%)
Mammals	298	10	6	16	5.4
Birds	742	32	11	43	5.8
Reptiles	397	-	14	14	3.5
Amphibians	208	22	6	28	13.5
Fishes	606	-	17	17	2.8
Total	2,251	64	54	118	5.2

Adaptation of both plants and animals to changing climatic pressures occurs over many generations and possibly hundreds or thousands of years. It would be extremely difficult to ensure the survival of species should the rate of climate change exceed the species' natural ability to adapt.

4.7.4 Coastal and Marine

Malaysia has 4,800 km of coastline. Malaysia's coastal and marine areas will be impacted by sea level rise, increases in sea surface temperature as well as changes in storm intensity and wave action.

(i) Sea Level Rise

Sea level rise is expected to cause the following:

- Inundation of coastal areas resulting in socio-economic loss or changes
- Saline intrusion that will affect agriculture
- Changes in salinity of coastal waters that will impact upon marine and aquatic life as well as aquaculture

The National Coastal Vulnerability Index (NCVI) Study (2007) assessed the vulnerability of coastal areas to sea level rise based on physical, biological and socio-economic parameters. The study was conducted at two pilot sites i) Tanjung Piai to Sungai Pulai, Johor and ii) West Coast, Langkawi. These sites were picked as they host a broad spectrum of uses. Tanjung Piai is the southern most tip of continental Asia with diverse land use including agriculture, port and maritime activities. A portion of the coast has also been gazetted as a Ramsar site. Tanjung Piai's mud coast is fringed by mangroves and, being on the southern-most point, faces both the Straits of Melaka and the Straits of Johor. A large stretch of agricultural land along this coastal belt is protected by bunds (embankments) with drainage outlets regulated by tidal control gates.

Pantai Cenang, in Langkawi is a sandy coast with mixed development including rural housing, tourist facilities (hotels and restaurants) and an airport that is protected by breakwaters. Sea level rise recorded in both these areas over 20 years was in the region of 1.3 mm/year. Global data show an average increase of 2 mm/year over the last century.

When the NCVI study results are superimposed on the global-high (worst case) projection for SLR of 10mm/year (1 meter by the end of the century), an estimated 1,820 ha of coastal land at Tanjung Piai and 148 ha at Pantai Cenang, Langkawi will be inundated. The affected areas include mudflats, mangroves and riverbanks. Furthermore, coastal roads and bunds are expected to be damaged by erosion.

(ii) Increase in intensity, duration and frequency of storms

Changing climate patterns are expected to increase the intensity, duration and frequency of storms resulting in enhanced erosion risk of coastal settlements and increased sedimentation risk of jetties and rivermouths.

(iii) Sea Surface Temperature Increase

The increase in sea surface temperature (SST) is one of the identified stressors for aquatic life such as coral reefs which thrive at optimum temperatures of 25°C to 29°C. Higher than normal water temperatures cause corals to expel the zooxanthellae living within their polyps. Prolonged absence of the zooxanthellae will kill the coral polyps, leaving behind their white calcium skeletons. About 85 percent of Malaysian reefs are threatened by this phenomenon and elevated sea temperature has been increasingly identified as one of the causes of reef degradation (coral bleaching) in recent years. Additionally, sea-surface temperature can also affect the physiology of aquatic life which in turn may have a direct impact on biodiversity and productivity. More studies however are required to fully understand changes in local sea surface temperature and aquatic vulnerabilities (C.R. Kaur, 2008)[47].

Coral bleaching, if it continues, will affect economic activities that are reliant on coral

47 Effects of Climate Change on Coral Reef Ecosystems, IMPAK, Issue 3/2008, pg 8.

reef ecosystems and services such as tourism, fisheries and coastal protection. For example, Malaysia's fame with renowned dive sites would be eroded as more coral bleaching occurs. Besides, livelihoods of fishermen would also be affected.

4.7.5 Energy and Transport

Impacts to the energy sector may be characterised as affecting oil and gas exploration, extraction, and transportation; and the generation, transmission, and distribution of electricity. Impact on transportation could affect the road, rail and aviation modes.

(i) Oil and Gas

Oil and gas exploration and extraction infrastructure, particularly if located offshore can be severely impacted by lightning and severe weather which can hamper operations and even result in the loss of life. Likewise, oil transportation is equally impacted by adverse weather conditions.

(ii) Electricity

Under the electricity generation sub-sector, projected increases in ambient temperature can be expected to reduce gas and hydro turbine power. At the same time, projected increases in sea-water temperature will decrease heat transfer in cooling facilities. Furthermore, the expected explosion in the population of certain species of marine animals, notably jellyfish, could hamper cooling by clogging intake pipes. Anticipated changes in sediment load caused by changing sea levels would have a similar effect. Excess rainfall could reduce water quality and impact cooling and water storage while prolonged droughts could affect hydroelectric power generation. Extreme weather events and the possible ensuing floods would damage power generation equipment and interfere with fuel delivery systems.

The power transmission and distribution sub-sectors could also be similarly affected as extreme weather could hamper maintenance work while the associated intense thunderstorms could erode the foundations of transmission pylons, increase the likelihood of landslides and increase damage due to lightning. Finally, floods could damage power transmissions and distribution infrastructure in low-lying areas.

(iii) Transportation

Road, rail and aviation under the transportation sector may also be impacted. Under the road and rail transportation sectors, changes in ambient temperatures would decrease transportation efficiency of vehicles and accelerate the deterioration of transportation infrastructure. Repeated flooding will damage roads, rail lines and bridges while strong winds can uproot trees, damaging vehicles and impede traffic flow. Road and rail traffic can also be impeded by landslides, which may occur more frequently with increased rainfall.

Higher ambient air temperatures could impact the aviation sub-sector by requiring lower takeoff weights while the increased incidence of extreme weather could cause delays and cancellations, or even pose a hazard to air travel.

4.7.6 Public Health

The focus of the analysis is on the impact of climate change on several vector borne diseases such as malaria and dengue and water related diseases such as diarrhoea. A preliminary analysis of pollution, temperature and health has also been attempted.

Increases in temperature and changes in rainfall have been studied in relation to the malarial and dengue vector mosquitoes. In both cases, it is projected that vector capacities will increase with temperature rise, resulting in greater and wider transmission of these diseases.

(i) Malaria

Malaria is transmitted by the *Anapheles* (An.) mosquito. In 2006, 57.2% of the cases were from Sabah, 26.7% from Sarawak and the remaining 16.1% were from Peninsular Malaysia.

Due to effective control measures, the

number of malaria cases detected in the country has dropped significantly and there is an opportunity to shift the current control programme into a total elimination programme.

Figure 4.2 shows the progressive reduction of malaria incidence in Peninsular Malaysia.

However increase in temperature and rainfall will further enhance the presence, survival and vectorial capacity of the malaria vectors. Studies using the vectorial capacity model [48]show that the An. maculatus mosquito's capacity to transmit malaria increases by 20 and 30 percent respectively with ambient temperature rise of 2°C and 4°C from the 1990 baseline (Ambu et al, 2003[49]). Thus, with the projected increase of 1.5°C in ambient temperature in 2050, the number of malaria cases is projected to increase by 15%.

Additionally, the An. maculatus breeds in small forest streams. Changes in stream flows due to changes in rainfall could affect its population.

An increase in areas with brackish water as a result of sea water intrusion from rising sea levels may lead to the wider spread of An. sundaicus, an important vector in the coastal area.

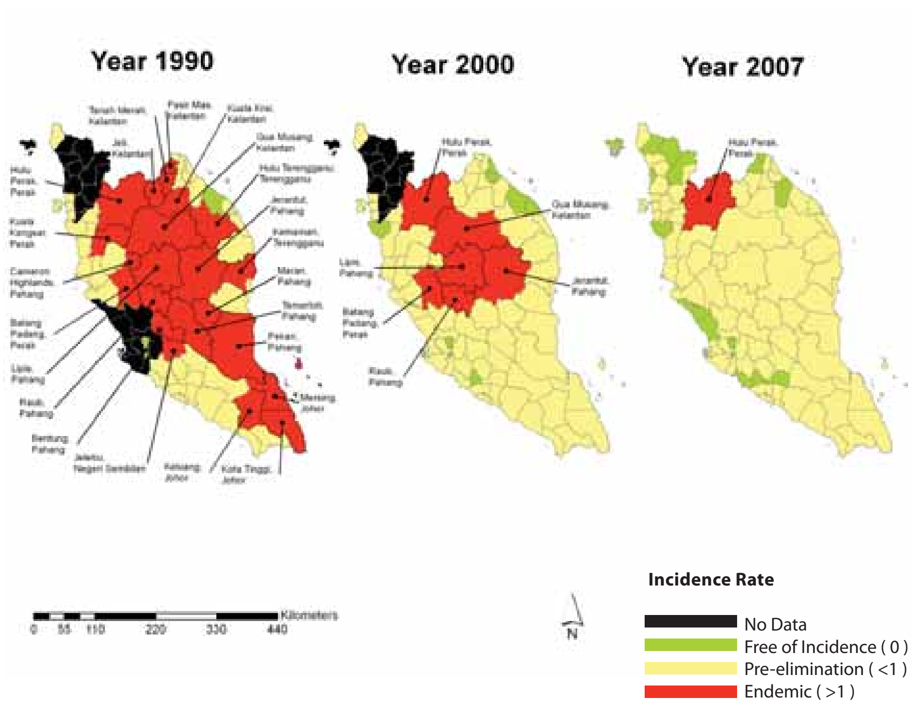
Apart from the flood plains and coastal areas which are still classified as malaria risk areas, the central region along the mountain ranges

48 The parameters used in this model namely the person-biting rate, person-biting habit, proportion of blood fed mosquitoes, length of gonotropic cycle, time required for the parasite to develop and daily survivorship of An. maculatus were all derived from local data.

49 Ambu S, Lee HL, Mazrura S and Mastura AB (2003). Climate change – impact on public health in Malaysia. Environmental Health Focus, 1: 13-21.

Figure 4.2

Changes in malaria incidence rate (per 1,000 population) by district in Peninsular Malaysia according to WHO classification.



would be the most vulnerable because of the difficulty in carrying out effective vector control. Furthermore, the factors above could cause the reintroduction of malaria in areas where it has been eradicated, mainly in urban areas. An epidemic could result due to the lowered natural immunities in these areas where malaria has been eradicated for a while.

(ii) Dengue

Dengue is transmitted by the *Aedes* (A.) mosquito: *A. aegypti* and *A. albopictus*. While the mosquito normally acquires the virus when biting an infected person and thereafter transmits it to others, recent laboratory studies (Rohani et al, 2008 [50]) show that the *Aedes* mosquito displays transovarial[51] transmission capacity of up to 5 generations, thereby sustaining the virus in the environment.

The average life span of the *Aedes* mosquito is 2 weeks. It also exhibits multiple feeding behaviour. An *Aedes* mosquito can bite several people during the short peak biting time in the morning between 6.00 to 8.00 am and late afternoon between 5.00 to 7.30 pm. Given the feeding times, it is difficult to control dengue with simple measures like bed netting which has proved successful in malaria control.

Each female can lay eggs about 3 times in a life time. About 100 eggs can be laid each time. *Aedes* prefers to lay its eggs in stagnant, clear water, usually in artificial containers rather than natural areas, around human habitation. Even when the containers dry up, the eggs can withstand desiccation for about 9 months. When exposed to favourable conditions of water and food, the eggs can hatch within a day and emerge as adults within a week. All these characteristics and behaviour make the *Aedes* an efficient vector.

Although studies linking climatic factors with dengue are limited in Malaysia, it is generally accepted that changes in precipitation, ambient temperature and humidity may influence the abundance and distribution of the mosquito vectors. Several studies have shown a positive relationship between rainfall and dengue (Malaysia- Li et al, 1985[52]; Thailand - Wiwanitkit, 2006[53]; Trinidad - Chadee et al[54], 2007; the Philippines -Su, 2008 [55]). The timing of rainfall also is as important as the amount of rain. However, extremely heavy rainfall may flush mosquito larvae away or kill them altogether (Promprou et al, 2005 [56]).

Furthermore, in a highly endemic state where disease transmission is at its height, rainfall may not significantly influence transmission dynamics as observed in an analysis conducted in Selangor. The relationship between rainfall and dengue between 1976-1980 compared to 2006 was lost despite similar rainfall patterns. The reason for this needs to be further investigated.

Warmer temperatures can increase transmission potential by allowing the mosquito vector to survive and reach maturity much faster and shorten the virus incubation

50 Rohani A, Zamri I, Joseph RT and Lee HL. (2008). Persistency of transovarial dengue virus in *Aedes* aegypti. Southeast Asian Journal of Tropical Medicine and Public Health, 39(5): 813-816.

51 Passing of the dengue virus by the host *Aedes* mosquito to its eggs and subsequently to the larvae and adult mosquitoes that emerge. The mosquito therefore carries the virus without first having to feed on an infected person.

52 Li CF, Lim TW, Han LL and Fang R. (1985) Rainfall, abundance of Aedes aegypti and dengue infection in Selangor, Malaysia. Southeast Asian Journal of Tropical Medicine and Public Health 16(4): 560-568.

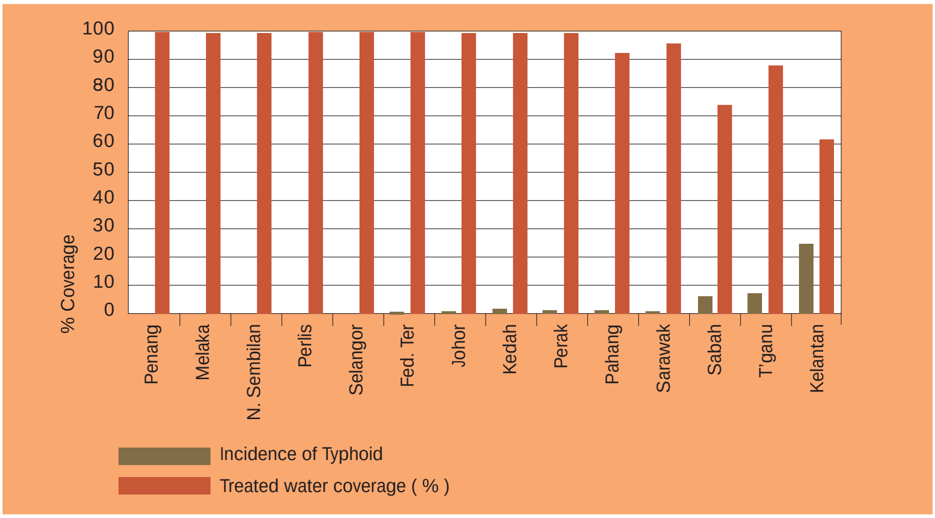
53 Wiwanitkit V. (2006) An observation on correlation between rainfall and the prevalence of clinical cases of dengue in Thailand. Journal of Vector Borne Diseases, 43(2): 73-76.

54 Chadee DD, Shivnauth B, Rawlins SC, and Chen AA. (2007). Climate, mosquito indices and the epidemiology of dengue fever in Trinidad (2002-2004). Annals of Tropical Medicine and Parasitology, 101(1): 69-77.

55 Su GL (2008) Correlation of climatic factors and dengue incidence in Metro Manila. Ambio., 37(4): 292-294.

56 Promprou S, Jaroensutasinee M and Jaroensutasinee K. (2005). Climatic factors affecting dengue haemorrhagic fever incidence in Southern Thailand. Dengue Bulletin. 29:41-48.

Figure 4.3
Incidence of typhoid in relation to percentage coverage of treated water supply.



period (Lindsay and Mackenzie, 1997[57]). Preliminary findings of an on-going study to develop a climate model for dengue showed that mean and minimum temperatures were positively associated with the *Aedes* population in Kulim, Kedah. As the minimum temperature increased, the larvae densities also increased.

Dengue is currently a highly endemic disease. The warm and humid tropical climate is favourable for the *Aedes* mosquitoes to breed and survive. In such a situation, socio-economic and human drivers play an important role in dengue transmission. Since 2002, dengue incidence continues to increase unabated. It is prevalent throughout the country with the highest incidence among the most developed and densely populated territories and states.

Clinical and laboratory confirmed cases showed that all age groups are affected with the most vulnerable among school going children and young adults. All ethnic groups are at risk of being infected with the highest incidence among the ethnic Indian population in 2006.

57 Lindsay and Mackenzie J (1997). Vector-borne viral diseases and climate change in Australian region: major concerns and the public health response. In: Curson P, Guest C, Jackson E. Editirs. Climate change and human health in the Asia Pacific region. Canberra: Australian Medical Association and Greenpeace International.

(iii) Food and Water-borne Diarrhoeal diseases

There are several modes of transmission for diarrhoeal diseases which include food, water, insect and contact with an infected person. The incidence of these diseases is greatly influenced by the level of sanitation and the availability of clean water supply.

The incidence of food and water-borne diarrhoeal diseases in this country in general is showing a declining trend over the years. The diseases are lowly endemic with the incidence of typhoid, cholera and dysentery at 0.77, 0.89 and 0.39 per 100,000 populations respectively in the year 2006. The diseases usually occur as sporadic outbreaks and the incidence by state is closely associated with the coverage of clean water supply. For example, the incidence of typhoid is highest among the states with the lowest coverage of treated water supply as shown in Figure 4.3 (ASM, 2007[58]).

58 Academy of Science Malaysia (2007) study report: Changing forest landscape impact on rural health.

The association of drought with cholera epidemics has been reported in Malaysia (Chen, 1970[59], Khoo, 1994[60]). The areas affected were those which have poor environmental sanitation, poor water supply, poor waste disposal and indiscriminate disposal of faeces (Yadav, 1990[61]).

The relationship between climate change and diarrhoeal diseases can come from the problem of availability of water in times of drought, where access to clean water to households may be compromised. Heavy rain and runoff can lead to contamination of surface water, again compromising clean water supply.

(iv) Pollution, temperature and health effects

Hot weather is associated with increasing mortality, especially among the elderly. Most of the increase in mortality from heat-waves is associated with cardiovascular, cerebrovascular and respiratory causes which is most prevalent among the elderly. Urban areas are more likely to be affected because of the urban heat island effect, where the temperature is much higher than the surrounding sub-urban and rural areas. Increasing temperature in urban areas may also enhance the trapping of pollutants in the air which will also contribute to increasing mortality from heat-waves. Preliminary findings of an on-going project on air pollution and mortality in the Klang Valley, showed that the risk of death was raised with the increase of pollutants. The impact of temperature on this outcome is currently being investigated.

There has been no real incidence of extreme heat-wave in the country and the impact of rising temperature on vulnerable groups, particularly the elderly, has not been investigated in the local scenario. The proportion of the elderly (65 year and above) is projected to be doubled from 4.3 percent in 2007 to 8.1 percent in 2030 but their distribution in urban, sub-urban and rural areas is not known.

4.7.7 Socio Economic Impacts

All the anticipated impacts of climate change to the key economic sectors are expected to have socio economic impacts as well. Economic growth, livelihood opportunities, actual incomes, workforce capacity and human health are all vulnerable to climate change impacts. Socio-economic vulnerabilities made up one of the determinants in the NCVI study underscoring the intrinsic nature of sector impacts and socio-economic impacts.

At the time of completion of this report, plans were underway to examine socio-economic impacts in greater detail for the sectors identified.

4.7.8 Cross-Sectoral

The cross-sector analysis based on a regional approach shows a strong linkage between all the sectors. Hence, within sector impacts and vulnerabilities affect other sectors too. Impacts on water resources appears to affect all other sectors. However, the vulnerability of this sector is dependent on all other sectors too. Well developed regions with high demands of water are most vulnerable to climate change.

Using a sector dependence approach wherein mutual reliance amongst sectors is considered, all sectors are found to be directly dependent on water resources, energy and the public health sectors.

4.8 Adaptation Measures

All sectors have identified several adaptation measures within their respective sectors. Some of these are in line with Malaysia's "no regrets policy" or have co-benefits in addressing other issues along with climate change impacts and are already being implemented. Some examples are efforts to

59 Chen, PYC (1970). Cholera in the Kedah River areas. *Medical Journal of Malaysia*, 24: 247 – 256.
60 Khoo A (1994). A study of two cholera epidemics in the district of Tawau, Sabah (1989-1991). *Southeast Asian Journal of Tropical Medicine and Public Health*, 25(1): 208 – 210.
61 Yadav, H (1990). Cholera in Sarawak: A historical perspective (1873-1989). *Medical Journal of Malaysia*, 45, 194-201.

reduce NRW in the water supply system and implementing research on developing new varieties of paddy that consume less water.

There are also laws, rules, regulations and policies that are sector specific that directly promote measures that can support climate change adaptation. For a holistic approach to climate change adaptation however, other existing laws, rules, regulations and policies will need to be reviewed and revised accordingly.

Some of the proposed adaptation plans by sectors are summarised below.

4.8.1 Water Resources

The implementation of the Integrated River Basin Management (IRBM) plan which takes into account integrated management of water resources, land resources, ecosystems and socio-economic needs will enable a more comprehensive approach towards reducing the vulnerability of this sector to climate change.

Laws like the National Water Services Commission Act, 2006 (NWSC Act) and the Water Services Industry Act 2006 (WSI Act) promote sustainable water use and better water management which are crucial in adapting to climate change.

Specific measures for the following water management categories are outlined below:

(i) Water Supply (Domestic, Commercial and Irrigation Use)

To address anticipated droughts, measures should be taken to:

- Enhance water supply efficiency. This includes improving storage efficiency by removing sediment from reservoirs and dams and eliminating losses from leakage and water theft.
- Promote demand management practices to reduce per-capita consumption of potable water by industrial, commercial and residential consumers. This includes reducing wastage through behavioural changes and encouraging water harvesting for non-potable uses.
- Promote demand management practices to improve the efficiency of irrigation and other water uses that rely on non-potable sources such as rainfall and groundwater.
- Improving management of water resources by incorporating weather forecasting data into a Decision Support System (DSS).

(ii) Floods and Erosion

In terms of the anticipated increase in floods the following measures should be considered:

- Review flood management plans and assess integrity of existing structures particularly where failure could result in loss of life (e.g. dams and large barrages).
- Review design standards for flood risk management in all new infrastructure including water control structures, transportation structures and electrical, water and waste amenities to incorporate climate change factors.
- Complement structural approaches with non-structural approaches such as improved rainfall and flood forecasting, disaster warning systems and flood hazard mapping as part of a coordinated disaster prevention and management plan.

4.8.2 Agriculture

(i) Oil Palm

An efficient drainage system is required to regulate water table depth and prevent floods. In water stressed regions, there should be sufficient irrigation facilities particularly during crop establishment.

Breeding programmes are needed to develop new varieties with high Water Use Efficiency (WUE) traits and drought tolerance.

(ii) Rice

Current rice varieties such as MR219 and MR232 can only be cultivated under moderate conditions. Research to develop additional rice varieties which are tolerant to floods, droughts and extreme temperatures should be continued.

(iii) Rubber

As projected changes in climate are generally expected to remain within the wide spectrum of temperature and total rainfall requirements for rubber plants, the main climate vulnerability faced by the rubber production industry is rain which could disrupt rubber tapping. Hence use of technologies such as the Low Intensity Tapping Systems (LITS) and Rain Gutters should be more widely implemented to protect against this climate related impact in this important economic sector. While this technology is already available, additional resources will be required to disperse it and to train and build capacities of workers.

(iv) Cocoa

Development of cocoa breeding programmes to develop drought, flood and disease tolerant clones are needed.

4.8.3 Forestry & Biodiversity

Components of biodiversity namely plant and animal species, ecosystem and genetic materials can be better conserved through the establishment of conservation corridors between forests. Genetic resources that may require further adaptation measures could be conserved through the establishment of gene banks.

Ex-situ conservation can be further enhanced through the establishment of seed centres and botanic gardens for flora and, animal sanctuaries, captive breeding centres and rehabilitation centres for fauna.

4.8.4 Coastal and Marine

Nationwide implementation of ISMP needs to be enhanced to reduce the impacts of sea level rise and more frequent storm surges caused by climate change.

(i) Sea Level Rise

Adaptation options that can be taken are as follows:

a. Retreat - abandonment of land and structures in vulnerable areas and resettlement of inhabitants; the prevention of development near coastal areas through the imposition of more stringent setback limits, land acquisition, land use restriction and prohibition of reconstruction in areas damaged by storms; and taking measures to enable wetlands to migrate inland.

b. Accommodation - continued occupancy and use of vulnerable areas. This constitutes a compromise between retreat and protection. This would entail modification of drainage systems, specifications of minimum floor elevation and piling depth as well structural bracing for building code; allowing changes in land use such as conversion of agriculture land to aquaculture uses; prohibiting filling of wetlands, damming of rivers, and mining of coral and beach sands; and allowing natural resources, such as mangroves and coral reefs to be left to their natural processes to cope with sea level rise.

c. Protection - defence of vulnerable areas, especially population centres, economic activities and natural resources. These include engineering responses which involve defensive measures to protect areas against inundation, tidal flooding, effects of waves on infrastructure, soil erosion and loss of natural resources such as mangroves. Consequently, hard measures such as sea-walls and groynes and soft measures such as beach nourishment and wetlands/mangroves creation are possible adaptation measures.

(ii) Increase in intensity, duration and frequency of storms

Measures to adapt would firstly involve obtaining a better understanding of storm patterns and potential responses through research. This would include:

- Research on storm surges to help establish quantitatively the trends of storm surges and wave patterns therefore facilitating the understanding of long term coastal evolution; and

- Research on coastal reforestation to develop optimal planting methods and the creation of robust coastal forests that can strengthen the stability of coastlines and contribute to biodiversity enhancement.

Additionally the wider usage of soft engineering should be promoted and widely applied as it is less damaging to the environment and in fact can enhance coastal ecosystems. Soft engineering applies both structural and biological concepts in the solving of erosion and reduction of erosive forces.

(iii) Sea Surface Temperature Increase

Research is required on the adaptation and recovery mechanisms of coral beds to enable appropriate measures to be undertaken. Artificial reef creation at a different site can be considered as a response measure. However this should be studied in greater detail and resorted to only as a last resort to maintaining and rehabilitating natural coral beds.

4.8.5 Energy and Transport

(i) Oil and Gas

Adaptation measures for the oil and gas sub-sector are categorised into short term projects (1-5 years) such as a study on the effects of climate change on the intensity and frequency of lightning strikes; medium term projects (6-10 years) such as improving/ upgrading of Lightning Protection Systems (LPS) at critical facilities and finally long term projects (more than 10 years) such as retrofitting/reinforcement of under designed oil and gas platforms to cater for extreme weather conditions resulting from climate change.

(ii) Electricity

Similarly, adaptation for the electricity sub-sector are categorised into short, medium and long term projects. Short term projects include continuous turbine efficiency improvement programmes and also studies on transmission line conductor thermal behaviour and marine animal behaviour in response to climate change. Medium term projects include medium term catchment management programmes for hydropower stations and the national implementation of grid connected rooftop solar panel. Long term projects include long term catchment management programmes for hydropower stations and intensifying research on a more efficient power transfer. Regular maintanence and upgrading of infrastructure in light of the anticipated impacts of climate change on structural integrity is also recommended.

(iii) Transportation

For the transportation sector, more resilient construction materials would be required in the future, as well as more frequent monitoring, maintenance and upgrades. Designs should also incorporate the potential impacts of climate change at the planning stages. Locations should be carefully chosen to avoid areas that would be landslide prone, or subject to sea level rise. Efficient early warning communication should be established.

4.8.6 Public Health

(i) Malaria

As discussed above, the number of cases now in Malaysia is so low that there is an opportunity to interrupt the transmission completely and to eliminate malaria as a public health problem in the country. The Vector-borne Disease Control Programme is in the process of revising the control programme into an elimination programme. Among the key approaches include strengthening and improving current strategies, changing the drug regimen to a more effective artemisinin combination therapy (ACT) as suggested by WHO to address the problem of drug resistant virus, strengthening the surveillance programme particularly in malaria free but prone areas to prevent re-introduction of the infection and occurrence of out-breaks, and improving the case detection mechanism and approaches, including screening of migrant workers. Emphasis should also be given towards entomological surveillance with the recruitment of entomologists at the district level.

Remote areas wherein most malaria cases presently occur and which are most vulnerable pose logistical challenges to implement and monitor control activities. The diminishing effects of insecticide both on wall surfaces as well as those impregnated into bed-nets necessitate the re-spraying and re-impregnation every six months. New formulation with prolonged residual effect is required to address this issue, which is currently being researched.

Vulnerability of the population to malaria infection in a given area is dependent on the presence or absence of the mosquito vector. Thus mapping of the areas for the malaria vector is the key in assessing vulnerability. Changing land-use and landscape may change the distribution of the mosquito vector. For example, urban environments are unfavourable to malaria vectors in this country. In contrast, clearing of forests for agriculture has often triggered the proliferation of malaria vectors. However, the traditional entomological survey methods are very laborious, time consuming and expensive to conduct. The utility of remote sensing data is currently being investigated as a tool to efficiently map vector distribution.

(ii) Dengue

The challenge in the control of dengue is the lack of effective tools that could be used against all the components of dengue transmission. Unlike malaria, there is no effective drug to treat and reduce the viral load in the patient. Personal protection using bet-net is not practical to control *Aedes* because of the biting behaviour of the mosquito vector. Vaccines are also not available.

Dengue is very much an environmental issue and keeping households, schools and the work environment free of *Aedes* is the key towards mitigating the dengue problem. This requires human behavioural adaptation. Transmission can only be halted completely by destroying breeding places and sustaining *Aedes*-free environments, which require full community participation.

More innovative mosquito control methods need to be developed. Dependence on chemical control as in current strategies may be challenged by insecticide resistance. Biological control using larvicidal bacteria has been shown to be effective against *Aedes* but has yet to be implemented and assessed in large scale application. Protection of the human host with the use of long-lasting repellent needs to be further investigated.

In the long-term, there is a need to review existing building designs (both domestic and commercial) and landscaping practices that may facilitate rain water collection and thus *Aedes* breeding. In this respect, new standards and guidelines may be required.

(iii) Food and Water-borne Diarrhoeal diseases

With regard to diarrheal disease outbreaks due to climate change, it is imperative that residents of flood/drought prone areas have access to clean and uncontaminated water especially during these events. Infrastructure needs to be in place to serve this need and avoid the contamination of water sources. Universal access to clean water and improvement in sanitation is important and hence there is a need for continuous improvement of sanitation and coverage of safe water supply. Under the Rural Water Supply and Environmental Sanitation Programme of the MOH, a target has been set to achieve 100% coverage of safe water supplies in the rural areas by the 10th Malaysia Plan (2011 – 2015).

Efficient communicable disease outbreak investigation and management is important. A Crisis Preparedness and Response Centre (CPRC) has been established in the MOH to monitor outbreaks and to initiate and coordinate responses. The establishment of the Centre for Communicable Diseases (CDC) further enhances disease surveillance and epidemiological investigation capacities and provides the much needed advanced laboratory support for efficient and effective communicable disease outbreak investigation and management.

4.8.7 Cross sector adaptation

There is also a need to develop cross-sector

V&A programmes. Each sector has some degree of dependency on other sectors. All sectors, for example, are dependent on water resources. The adaptation options therefore cannot be limited to just within sector initiatives but should also be cross-sectorial. For example, increased irrigation water efficiency in the agriculture sector would allow for more available water for domestic use. Another form of adaptation is in the form of sectorial sacrifices. This can be achieved by changing existing landuse in areas affected by sea level rise from say, tourism to aquaculture or relocating paddy production areas from fast growing urban and industrial areas. Such options require careful yet advance planning as they involve long-term implementation for effectiveness.

4.9 Recommendations

The present climate change projections indicate more severe climate events and conditions up to 2050 and beyond. Efforts should be taken now to address these issues, particularly towards selecting and implementing appropriate adaptation measures. It is all the more necessary since all present development, social planning objectives and implementation programmes of the country are based on assumptions with limited quantified climate change impacts. These plans and objectives could be severely affected if vulnerabilities are not addressed now. The following recommendations should be urgently considered:

a. A formal V&A capacity building programme should be developed and implemented immediately for all sectors and including financial, economic and social fields. This should include education and training, development of models and information and communications technologies (ICT) infrastructure as well as recruitment of experts and specialists from around the world. Special research programmes should also be implemented to fill-in the existing knowledge and information gaps.

b. An integrated V&A programme for all sectors should be implemented and based on a regional or eco-system based approach. This programme should also include an integration of data and information collected for sharing between all sectors.

c. To encourage wider participation of professionals and the public, climate change and V&A data and information should be readily accessible to them such as through the internet. At the same time, guidelines for V&A should be developed for all sectors including the public. Special programmes should also be developed to assist the public in selecting options for adaptation to climate change.

d. Within sector V&A initiatives should continue and with special focus on critical mitigation measures such as the structural integrity of major structures that would cause disasters if they failed. This is also necessary to ensure uninterrupted services of all utilities particularly energy and water resources and with good contingency plans during extreme events. Disaster risk management plans should be implemented and public participation must be emphasised.

e. Laws, rules, regulations, policies and plans related to all sectors should be reviewed and new ones introduced to strengthen efforts to address climate change issues and encourage adaptation measures.

f. There is an urgent need for affirmative climate change programmes for all sectors and it is recommended that an integrated climate change adaptation programme be included in each of the five year development plans.

4.10 Conclusion

The analysis in this NC has enabled a better understanding in terms of sectoral vulnerabilities especially with the availability of nation specific climate projections. This in turn has provided the basis for adaptation proposals to be formulated. The next step would not only be implementation of some of the more urgent recommendations, but continuous monitoring and evaluation.

Furthermore, the information and understanding gathered through these detailed sectoral analysis can form the basis of advancing towards a more holistic approach in terms of regional or ecosystem V&A analysis to enable the formulation of more integrated solutions. This has already been employed to some degree in the Coastal and Marine analysis, especially in formulating the NCVI. Future V&A analysis should adopt this approach more widely, using inputs from in-depth sector analysis as a basis.

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Chapter 5

RESEARCH, TECHNOLOGY TRANSFER AND SYSTEMATIC OBSERVATION

CHAPTER 5: RESEARCH, TECHNOLOGY TRANSFER AND SYSTEMATIC OBSERVATION

5.1 Research

Following the recommendations in the INC, Malaysia undertook several research activities specifically relating to climate change. In most cases they have been implemented purely through national efforts, although a few were implemented with technical support from outside.

The following are some of the key research activities in various areas that have been undertaken or are currently being undertaken:

5.1.1 Regional climate change modelling

Regional Climate Models (RCMs) evaluate the extent to which the climate in a particular region will be influenced by climate change. Regional climate dynamic modelling is being undertaken at the Malaysian Meteorological Department (MMD). The RCM used is the Providing Regional Climates for Impacts Studies (PRECIS) developed at the Hadley Centre, United Kingdom Meteorological Office.

A regional hydrologic-atmospheric model, called the RegHCM-PM, has been developed by the National Hydraulic Research Institute Malaysia (NAHRIM) in order to downscale available global historical and climate change atmospheric databases that were produced by the Canadian Global Climate Model First Generation (CGCM1) at a coarse grid resolution (~410km), to Peninsular Malaysia at fine spatial resolution (~9km). It is known that more refined topographic & land characteristics at local and watershed scales have profound impact on regional climate. Furthermore, land use patterns/ changes impact regional climate conditions. Thus, the climate change data at such coarse spatial resolution cannot be used directly for evaluating climate change at local and watershed scales for Peninsular Malaysia. Downscaling of the coarse scale global climate model (GCM) data to local scale and watershed scale of Peninsular Malaysia provides the projections for understanding the potential long-term climate and hydrologic impacts of global warming on the hydrologic regime and water resources of Peninsular Malaysia.

A similar study for Sabah and Sarawak is presently underway.

5.1.2 Coastal vulnerability study

Sea level rise due to global warming is expected to cause coastal impacts such as shoreline erosion, salt water intrusion, inundation of wetlands and estuaries, and threats to cultural and historic resources as well as infrastructure. In this regard, the Department of Irrigation and Drainage (DID) undertook a study on the NCVI at two pilot sites at Tanjung Piai, Johor and Pantai Cenang, Langkawi (2006-2007).

The NCVI is a composite of three vulnerability parameters namely physical (geological and coastal hydrodynamics including sea level rise), biological (vegetation, flora, fauna and ecosystems) and socioeconomic (effect on local populace, socio-economic activities and infrastructure). Consequently, a specific methodology for a national-scale vulnerability assessment has been developed which can then serve as a planning tool for the development of the coastal areas.

5.1.3 Forestry Sector

(i) National Forest Inventory (NFI)

Forest inventories are conducted every ten years in Peninsular Malaysia. The number of seedlings, growing stocks, total timber volumes and biomass in forests are accounted in the inventory. In addition, growth and yield plots have been established in many sites since the 1970s and periodic evaluations are conducted. Findings from the NFIs show an increase in growing stocks from 222 m^3/ha in 2000 to 251 m^3/ha in 2005.

(ii) Carbon Sequestration

A key achievement is the Comparative Studies on Carbon Sequestration Potentials to obtain carbon sequestration potentials from different ecosystems. Some of the results from these studies enabled Malaysia to prepare the LULUCF inventory using more accurate emissions factors. Growing stocks in forest had increased between 1990 and 2000, resulting in large carbon stocks and CO_2 removal.

The uptake by the forest is about 4 t C/ha/yr while the other plantation crops removed between 5-8 t C/ha/yr. However, the carbon stocks in natural forest are between 60 - 150 tC/ha as compared with 50 - 70t C/ha by plantation crops.

(iii) CO_2 Flux Observation

Long term CO_2 flux measurements in forests are monitored in the Pasoh Forest Reserve in Negeri Sembilan, Peninsular Malaysia and the Lambir Forest Reserve, Sarawak. The CO_2 flux estimation measures the vertical CO_2 profiles above and within the forest. Meteorological parameters, soil CO_2 efflux and net ecosystem exchanges are also monitored.

Short-term observation at Pasoh tropical forest suggested the forest is a CO_2 sink. The CO_2 flux is estimated between -1.0 to 0.5 mg CO_2 m^{-2} s^{-1} and the daily net ecosystem CO_2 exchange (NEE) ranged from -2.08 to -2.74 g C m^{-2} per day (Yasuda et al., 2003[62]; Takanashi et al., 2005[63]).

Long-term average diurnal change of CO_2 flux within the forest in Pasoh was estimated between -18.0 to 10.0 μmol $m^{-2}s^{-1}$ and suggested insignificant seasonal changes (Takanashi et al. 2005). Rainfall pattern is an important environmental factor that determines gas exchange in tropical forests.

62 Yasuda, Y., Y. Ohtani, Watanabe, T., M. Okano, T. Yokota, N. Liang, Y. Tang, Abdul Rahim Nik, M. Tani, and T. Okuda. (2003). Measurement of CO2 flux above a tropical rain forest at Pasoh in Peninsular Malaysia. Agricultural and Forest Meteorology, 114: 235 – 244.

63 Takanashi, S., Y. Kosugi, M. Tani, N. Matsuo, and T. Miani. (2005). Characteristics of the gas exchange of a tropical rain forest. Phyton special issue: 6th APGC 2005, 10 (45): 61 – 66.

5.1.4 Energy Sector

Research has been ongoing on using renewable energy (RE) for power generation since the 7th Malaysia Plan (1996–2000) with various research grants provided to universities, research institutes and industries. Up to now, a total of 176 projects have been funded amounting to RM 154 million. The R&D for RE is focused on developing technologies to harness energy from biomass, solar, micro/pico hydro, winds and oceans. Most of these projects are still on a pilot scale and will need further refinement prior to commercialisation.

An example is the Biomass for Generation and Co-Generation Project (BIOGEN). This project was launched in 2002 to promote biomass-based electricity generation. The objective was to reduce the growth rate of GHG emissions from fossil fuel fired combustion processes and to develop and exploit the energy potentials of biomass waste through the planting up of power generating capacity by using co-generation technology.

The Green Energy Office (GEO) Building, previously known as the Zero Energy Office (ZEO) Building, which is the headquarters of Greentech Corporation Malaysia at Bangi, was developed following the success of the Low Energy Office (LEO) Building of the Ministry of Energy, Green Technology and Water (MEGTW) of Malaysia. It was designed to demonstrate that a building can use less fossil fuel and instead use power from its own RE generation system using innovative green technology available today.

The building has been officially operated from November 2007 and data for one year has been recorded. Fine tuning has been carried out for further reductions in energy consumption since its official opening.

The design of the building incorporates features such as Active Systems, Passive Systems, Renewable Energy Systems and Environment Protection. The first of its kind in Malaysia, the GEO Building sets a new standard of energy efficiency in office buildings using the BIPV system. Four different PV systems using four different technologies are installed in this building.

The GEO Building like the older LEO Building, demonstrates the feasibility of energy efficiency measures according to the Malaysian Standard MS 1525:2007 "Code of Practice on Energy Efficiency and the use of Renewable Energy for Non-residential Buildings" and the "Malaysian Standard (MS 1837: 2005) for Installation of Grid-Connected Photovoltaic". The GEO Building was designed to have a lower energy consumption of 65 kWh/m^2/year compared to the LEO Building which is about 100 kWh/m^2/year.

Besides the Government, the private sector also plays an important role in R&D for RE. The initiatives taken by the private sector for RE R&D include research focusing on utilising biomass, biofuel, fuel cells, solar power and wind power for energy generation.

5.1.5 Biofuel from Palm Oil

The development of biofuel using palm oil has been undertaken in line with the initiative to make Malaysia a world leader and hub for palm oil. Biofuel production using palm oil to be used as biodiesel for vehicles has been developed using a mixture of 5 percent palm oil and 95 percent fossil fuel. The government recently announced plans to implement its use in vehicles from 2011. Although the Biofuel Policy 2006 planned for this to be implemented earlier, these plans have been somewhat delayed due to the hike in palm oil prices as a result of the increase in oil prices in 2008.

Malaysia remains cognizant of the perception by some that increased production of palm oil biofuel will jeopardize the edible oil industry and act as yet another driver of deforestation and emissions, particularly from peat soils. Malaysia has taken strong measures to determine the impacts of producing renewable biofuel from palm oil. Current findings indicate that the oil and biofuel yield per hectare of oil palm is approximately seven times the average yield of other traditional staple oil crops such as soy bean, sunflower and rape seed, enabling food and energy demands to be met more efficiently.

5.1.6 Public Health

A study on the malaria vector's capacity to transmit the disease with temperature rise has been conducted with results showing increases by 20 and 30 percent respectively with an ambient temperature rise of 2°C and 4°C from the 1990 baseline (Ambu et al, 2003)[64].

In terms of dengue, recent laboratory studies of transmission patterns reveal that the virus can be sustained in the environment as the *Aedes* mosquito displays a transovarial transmission capacity of up to 5 generations (Rohani et al, 2008)[65]. Studies are also ongoing on the relationship between rainfall and dengue transmission dynamics as well as developing a climate model for dengue. Methods of biological control of mosquito larvae has been researched by the Institute of Medical Research (IMR) and findings show this to be effective either on its own or in combination with insecticide.

A study on air pollution and mortality in the Klang Valley which showed that the risk of death was raised with the increase of pollutants has been expanded to examine the impact of temperature on this outcome.

5.2 Technology Transfer

Malaysia has participated actively in the CDM mechanism under the Kyoto Protocol. As of August 2010, 83 projects have been registered by the Executive Board in Bonn Germany. The Malaysian Government has established the necessary CDM institutional framework. The two tiered establishments consist of the National Committee on CDM (NCCDM) and its technical committees. The Environment Management and Climate Change Division under the Ministry of Natural Resources and Environment is the CDM Designated National Authority (DNA) and the

64 Ambu S, Lee HL, Mazrura S and Mastura AB (2003). Climate change - impact on public health in Malaysia. Environmental Health Focus, 1: 13-21.

65 Rohani A, Zamri I, Joseph RT and Lee HL. (2008) Persistency of transovarial dengue virus in *Aedes* aegypti. Southeast Asian Journal of Tropical Medicine and Public Health, 39(5): 813-816

secretariat to the NCCDM.

Realizing that technology transfer is a critical aspect of developing programmes aimed at mitigating climate change, the NCCDM has set up the national CDM criteria so that the projects approved, amongst others, must provide technology transfer benefits or improvement of technology to local project proponents. In order to ensure the effective transfer of technology and improvement, the proposed CDM project therefore should demonstrate measureable impacts on indigenous capacity to apply, develop and implement environmentally sound technologies.

5.3 Systematic Observations

At present there is no single institutional structure to collect data and information specifically for climate change monitoring and impact assessments. Nevertheless Malaysia has a network of climate and hydrological monitoring stations for systematic and continuous data collection. These are led by the Malaysian Meteorological Department (MMD) for climate and the Department of Irrigation and Drainage (DID) for hydrological data. Other departments also collect similar data for their own functional purposes and these include the Department of Environment (DOE), the Department of Minerals and Geoscience and the Department of Agriculture (DOA). Private institutions also collect similar data particularly in the oil palm and rubber plantations sectors.

The information on systematic observations below updates or further substantiates the information contained in the INC.

5.3.1 Climate Observation Stations in Malaysia

The MMD operates several climate observation stations and global atmospheric watch stations.

(i) Climate Observation Stations

The MMD currently operates 42 principal surface weather observation stations at airports and some selected areas, more than 143 automatic weather stations and about 300 auxiliary meteorological stations operated by volunteers to observe and collect meteorological data. Most of the auxiliary stations measure daily rainfall only and some also measure daily minimum and daily maximum temperatures. MMD also operates 8 upper air observations stations which release two radiosondes per day. The data collected undergo stringent checks to ensure quality. A relational database was developed in 2002 to archive data and for the provision of climatological services to the users.

Of the 42 principal stations, 28 are in Peninsular Malaysia, 5 in Sabah, 8 in Sarawak and 1 in the Federal Territory of Labuan. Of the 143 automatic weather stations, 120 are in Peninsular Malaysia, 15 are in Sabah, 8 in Sarawak and similarly for the auxiliary stations, about 50 are in Sabah, 8 in Sarawak and the rest in Peninsular Malaysia. However increased coverage especially of principal stations in Sabah and Sarawak and automatic stations throughout Malaysia is required.

(ii) Global Atmospheric Watch (GAW) Stations

The GAW Programme of the World Meteorological Organisation (WMO) is to coordinate the global atmospheric chemistry observation, analysis and scientific assessments related to the changing composition of the earth's atmosphere as to address its influence/effect on weather, climate, water and the environment. Malaysia through the MMD has participated in the worldwide network of GAW since 1998. Malaysia currently operates three GAW stations as follows:

- Baseline GAW Station at Danum Valley Sabah
- Regional GAW Station at Tanah Rata, Cameron Highland
- Urban GAW station in Petaling Jaya at MMD Headquarters, Petaling Jaya

5.3.2 Public Health

Continuous surveillance data for selected communicable diseases are available as reporting or notifying of infectious diseases is mandated by the Prevention and Control of Infectious Diseases Act 1988. The Notification Regulation was last updated in 2006 whereby a total of 26 infectious diseases and any life threatening microbial infection are required to be notified by law. Some of the data collected were malaria and dengue incidence rates, as well as incidence of selected food and water borne diseases in Malaysia.

5.3.3 Energy

Malaysian Green Technology Corporation, MGTC, (formerly known as Pusat Tenaga Malaysia), has been publishing data on the National Energy Balance (NEB) since its establishment in 1998. The NEB compiles final energy demand and commercial energy supply data for the country. The data for NEB preparation are provided by energy suppliers and consumers in Malaysia consisting of Petroleum Refineries, Gas Processing Plants, Electricity Power Producers, Energy Marketing Companies, Primary Energy Production Companies and Coal Mining/ Consuming Industries, on a voluntary basis. With the introduction of the Malaysia Energy Database and Information System (MEDIS), the data providers are able to submit their data on-line to MGTC.

Chapter 6

CAPACITY BUILDING, EDUCATION, PUBLIC AWARENESS, INFORMATION AND NETWORKING

CHAPTER 6: CAPACITY BUILDING, EDUCATION, PUBLIC AWARENESS, INFORMATION AND NETWORKING

6.1 Introduction

The INC and several national programmes provided strategic guidance that steered the country towards undertaking several initiatives. Through these initiatives, the nation's capacity has been enhanced in dealing with climate change. The preparation of the NC2 has benefited from this foresight and has therefore been able to rely on more quantitative analysis based on the availability of more local data.

Generally an increasing number of activities to educate the public on the myriad issues concerning climate change has been observed and overall public awareness of the issue can be said to have increased. New media using the internet has been instrumental in information sharing and networking especially amongst youth.

6.2 Capacity Building

One key avenue through which capacity has been built in Malaysia is through climate change projects. Apart from building the capacity of local experts on issues relating to climate change, these projects have also generated much needed local data, information and appreciation of the multi-sectored nature of climate change. They have also improved the skill sets required in planning for the actions to be taken.

The Climate Change Modelling Capacity Building Project since 2006 has built capacity in terms of using the PRECIS model developed by the Hadley Centre. The purpose was to generate scenarios for the 21st century using baseline data. Malaysian meteorologists and other experts have gained these skills mainly through free access to the model and the training provided by the Hadley Centre. MMD, NAHRIM and Universiti Kebangsaan Malaysia (UKM) are all involved in conducting runs of this model.

NAHRIM has also developed a regional hydro-climate model (RegHCM-PM) and has simulated projections for two 10-year periods in the future (2025-2034 and 2041-2050) comparing the results to hydro-climate simulations for the historical period of 1984-1993. This effort has built local capacity in hydro climate modelling and generated national data at a fine spatial resolution of nine square km grid for the Peninsula. Similar efforts are underway in Sabah and Sarawak presently.

Other significant capacity building projects include the Multilateral Environmental Agreement (MEA) project, a Malaysian Government/Danida project, to support Malaysian participation in international negotiations and national implementations of commitments under selected MEAs including the UNFCCC. There has also been enhancement of the role of environmental journalism in Malaysia. Both these projects were undertaken between 2004-2006.

With regard to CDM, capacity building activities have also been undertaken by the DNA and its respective technical secretariats. The main objective of the capacity building programme is to raise awareness on the opportunities and benefits offered by CDM. In addition, the secretariat staff attended short courses overseas and locally to stay abreast of the latest developments in CDM issues. Since 2004, more than 30 capacity building activities consisting of workshops, seminars, colloquiums, courses and forums have been carried out by the various secretariats.

Apart from the above, during the course of the NC2 project, stakeholder capacity was built through attending domestic and regional workshops on key areas and also through hands on involvement in the preparation of this report. Confidence in inventory preparation has increased with the review by external experts of the application of the IPCC 1996 Guidelines in preparing the national inventory in three of the five key areas (Energy, Industrial Processes and LULUCF). Skills have also been built to advance to the next phase of inventory preparations that combines the Agriculture and LULUCF sectors into one as Malaysia participated in the Agriculture Land

Use (ALU) model training programme for South East Asia by UNFCCC and USEPA. The opportunity to attend regional workshops on Long-range Energy Alternative Planning (LEAP) model application and on V&A analysis not only introduced new tools and methodologies in a systematic manner, but also provided the avenue for local experts to meet and discuss matters of common interest with resource speakers and others around the region. All these activities were collaborative efforts between the Government of Malaysia and UNFCCC, NCSP, UNDP and/or donor countries.

Capacity in inventory preparation was further enhanced through Malaysia's participation in the Workshop on Greenhouse Gas Inventories in Asia (WGIA) programme from 2003 onwards. In acting as host country for the 6th WGIA meeting 2007 and the Regional Workshop on Second National Communications and V&A Assessments for Asia 2009, Malaysia benefitted from having a greater number of participants and direct capacity building.

Overall, the direct involvement of various government agencies and other stakeholders in the preparation of the NC2 has also fostered greater understanding and cooperation amongst them with regard to addressing climate change.

6.3 Education

Efforts to educate Malaysians on the issues of the environment and sustainable living in general and climate change specifically have been ongoing. These range from greater course content relating to these subjects in various disciplines in higher education institutes, and equally importantly, through seminars and conferences as well as competitions.

In line with the country's thrust to promote green technology and sustainable development, programmes ranging from engineering, science, technology and the natural sciences to the arts and social sciences have been introduced not only as courses but also to inculcate a deeper understanding of 'sustainability'. This is with the aim of motivating students to be more involved, committed and dedicated for the sustainable wellness of an institution, community, and global environment. Furthermore, universities have also taken steps to reinvigorate their R&D activities especially in areas of sustainable development.

Apart from using the formal education channels, initiatives have also been undertaken to educate the wider public. These include the *Suria 1000* project with the objective to promote and educate the public on the use of solar, especially grid connected PV systems and the energy star ratings for certain electrical goods like refrigerators and air conditioners to guide the public on lower energy consumption choices. Enabling consumers to make more informed choices on property purchase through building ratings has also started. A local index called the Green Building Index (GBI) has been created to cater for local circumstances.

Seminars and conferences organized by various organisations ranging from government ministries and agencies to NGOs and the private sector have disseminated information on issues such as international climate negotiations, climate change and extreme weather, Reducing Emissions from Deforestation and Forest Degradation (REDD) and CDM to a wide audience. For example, the NRE organised the *Regional Conference on Climate Change – Reducing the Threats and Harnessing the Opportunities of Climate Change* in 2007 bringing together a pool of renowned international and local experts, some of whom were sponsored by the British High Commission. The *National Seminar on Socio-Economic Impacts of Extreme Weather and Climate Change* by the Ministry of Science, Technology and Innovation in 2007 highlighted the extent of potential climate change impacts.

The Centre for Environment, Technology and Development, Malaysia (CETDEM) has regularly organised seminars on climate change, often in collaboration with NRE and foreign embassies, to inform the public about the outcomes of international negotiations. The Environmental Protection Society of Malaysia (EPSM) in collaboration with

NRE and the Ministry of Housing and Local Government introduced the idea of Ecological Footprint in Malaysia during its *Sustainable Living in Malaysia (SLiM)* conference in 2007. Similar initiatives have also been taken by other NGOs such as the Malaysian Nature Society (MNS) and Worldwide Fund for Wildlife (WWF) Malaysia to educate civil society to be better equipped to contribute towards solutions.

Various competitions held have also helped to educate the public on the issue of climate change, the environment and sustainable living through the implicit need of gaining knowledge on these matters to participate. These include essay writing, photo, short film, sustainable schools, and engineering design competitions by government and non-government organisers, with an increasing number of private sector organisers.

6.4 Public Awareness

While overall public awareness on climate change and environmental issues can be said to have grown, only limited evidence of this can be noted from changed behavioural patterns. Indications of improved public awareness include an increase in the number of companies adopting sustainable practices, taking the approach that these are in line with their other goals, as well as initiatives by university students and some local councils to be green and sustainable. Increasingly also, announcements, especially by corporate entities, on green initiatives, from engaging in recycling activities to pledges on carbon emission reductions get newspaper coverage, reflecting that readerships do care about these issues.

Top down initiatives have been ongoing by the Government which has also recently introduced measures like tax incentives and a green technology fund to act as change catalysts. These are complemented by bottom up approaches such as public service messages aired by radio stations and seminars like those organised by the Business Council on Sustainable Development Malaysia (BCSDM) to raise public knowledge on climate change. CETDEM ran a three and half year "Mobilising Malaysians on Climate Change" Project from 2001 to 2004 through which it reached stakeholders ranging from the general public to legislators. The project also developed a Climate Change Action Plan which was submitted to the government.

Creativity has also been infused into increasing public awareness. The Malaysian Environmental NGOs (MENGO) is in its second year of organizing the Green Hunt, a treasure hunt using public transportation rather than the conventional convoy of motor vehicles. CETDEM has organized several *Hari Organik* (Organic Day) events featuring organic products and promoting sustainable practices like composting in a lively and engaging environment. The rapid growth of organic produce portrays a shift in lifestyle choices especially in the urban areas.

An innovative partnership involving the government through NRE with interested parties and with UNDP support provides a channel for voluntary carbon emissions offsetting domestically using the *Voluntary Carbon Offset Scheme* (VCOS). The pilot project with the national airline carrier launched in 2008 has enabled passengers to learn about their carbon air miles and make a voluntary contribution towards offsetting it. A modest sum has been collected to date which goes towards the integrated management of a peat swamp area in the country, providing for replanting, conservation and sustainable livelihood activities.

Awards like the Prime Minister's Hibiscus Award and the Langkawi Environment Award recognise achievements by the business sector and individuals respectively. The inclusion of an "Environment" category amongst the five categories of the Merdeka Award to highlight contributions towards the well being and advancement of the nation reflects the growing importance of environmental issues to the country.

6.5 Information and Networking

Various organizations have been actively involved in information sharing and networking.

NAHRIM is the Regional Water Knowledge Hub for Water and Climate Change

Adaptation in South East Asia under the Asia Pacific Water Forum. In this role, Malaysia hosted the *Regional Workshop on Developing Partnerships for Water and Climate Adaptation* in 2008. NAHRIM will be publishing a guideline on the use of the RegHCM-PM model database/results for professionals and the general public in the region. This is expected to enable wider participation in the use and application of the data generated by the model which in turn is expected to encourage information sharing and exchange between the users. The guideline will also facilitate data collection by users for V&A exercises.

The establishment of MENGO has increased coordinated and cohesive contributions by civil society and provided a more effective interface for dealings between environmental NGOs and other stakeholders such as the government and the private sector. Youth networks concerned with the issue of climate change and the environment in general have also sprung up. The Malaysian Youth Climate Justice Network (MYCJN) and the $E=MC^2$ (Malaysia Can Change for a Better Environment) are two examples. MYCJN provides a platform for youths to network and share ideas with the goal of enlarging the pool of change agents to help spread their shared concerns regarding climate change. $E=MC^2$ is a network of local university environment groups who engage in activities within their respective campuses to promote environmental awareness and inculcate sustainable living habits. ICT has been a great enabler for these networks.

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Chapter 7

CONSTRAINTS AND NEEDS

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CONSTRAINTS AND NEEDS

7.1 General Priority Needs

General constraints, gaps and needs for implementation of the UNFCCC were identified as part of the National Capacity Self Assessment for Global Environmental Management (NCSA) process from 2007–2008. The NCSA was an UNDP-GEF Enabling Activity Project, and the self-assessment encompassed implementation of the Convention of Biological Diversity, UNFCCC and the UN Convention to Combat Desertification. The following are the priority needs for implementation of the UNFCCC identified and documented in the NCSA:

a. Coordination among various ministries and departments in terms of addressing climate change could be further improved. As climate change matters are being mainstreamed into national and state coordination and policy planning, the roles and mandates of respective agencies in addressing climate change need to be clearly expressed.

b. There is a lack of technical capacity/ scientific information/research and development to carry out vulnerability assessments and also implementing mitigation options. One of the reasons is that there are insufficient dedicated research programmes and funding to support decision making relating to addressing climate change.

c. Eventually, the implementation of a strategy and action plan on climate change will require an overall and comprehensive monitoring mechanism. Information may lie with many implementing agencies. It is important to share relevant information for decision-making and mechanisms to do so are required.

In addition there were also gaps that are common to the implementation of other Multilateral Environmental Agreements (MEAs), particularly with issues and sectors of the Convention of Biological Diversity. The gaps indentified in these areas were in terms of:

d. Improving capacity in negotiation.

e. Strengthening policy, institutional and legal framework.

f. Mainstreaming awareness and public participation.

To address the constraints and gaps identified above, the NCSA process had recommended action plans that are focused on the following areas:

a. Strengthening of institutional framework / mechanisms among various government agencies for implementation of the UNFCCC.

b. Developing a framework for research and development, as well as observation systems to support the climate change agenda.

c. Review and identify synergies in relation to the implementation of the National Policy on Climate Change, National Green Technology Policy, National Policy on Environment, National Policy on Biological Diversity, and relevant action plans on land degradation.

d. Establishing a regular reporting framework on the implementation of Strategies and Action Plans pertaining to climate change.

e. Rationalise and consolidate environmental laws and regulations to address cross-cutting issues and reduce conflicting concerns.

f. Enhance the role of the Centre of Public Understanding of the National Institute of Public Administration so as to develop training for decision-makers in strengthening their abilities to mainstream the agenda of climate change, conservation of biodiversity, and land degradation in federal and state administrations and institutions.

g. Enhance institutional frameworks and processes for public environmental awareness and education programmes.

7.2 Constraints

During the preparation of the NC2, three (3) thematic working groups, namely GHG Inventory; Mitigation; and V&A were established to prepare relevant assessments. This section presents:

- Constraints and gaps that were identified based on topics within these working groups, together with examples, and
- Actions identified to address gaps and constraints, together with examples.

Appendix 3 presents a summary of the constraints and recommendations.

7.2.1 GHG Inventory

(i) Constraints and Gaps

The main constraints are related to lack of quality data and information, and the lack of expertise in the respective sectors. Due to the unavailability of relevant data, assumptions were made and data obtained from secondary sources.

The following are examples of some of the challenges encountered in preparing the GHG Inventory:

- Lack of local emission factors (hence the more general IPCC default factors were used).
- Available data is not segregated according to IPCC Guidelines categories.
- Gaps in knowledge and skill in understanding the relationship between processes especially industrial processes and emissions released.
- Lack of centralised activity data collection and compilation in all key sectors.
- Lack of historical data for relevant sectors such as forestry, agriculture and waste.
- Financial constraints for the task of inventory preparation.

(ii) Actions Identified to Address Constraints and Gaps

In order to ensure the sustainability of preparing GHG inventories, the capacity built and processes established during the NC2 process should be institutionalised and improved. The roles of Government and other supporting agencies in building reliable and sustainable inventories are to be continued and enhanced.

The understanding of recent IPCC guidelines, such as the Good Practice Guidance (2003) and IPCC 2006 Guidelines is important for future inventory preparation. In order to apply these guidelines, national capacity-building and technical assistance are required. These include training on uncertainty analyses and quality assurance/quality control procedures. In addition, capacity building is also required to ensure that data providers are able to provide relevant information.

Actions to improve inventory preparations have also been identified which include:

a. Developing a detailed plan to improve data collection for inter alia:

- Water regime, fertilizer consumption in the agricultural sector with a view to centralising this in the long run;
- Waste water treatment of food and beverage industry, recycling rate, and methane recovery at landfill sites in the waste sector; and
- Activity data and emissions factors for soil.

b. Improving the understanding of carbon content from land use and its changes in soil types.

c. Promoting collaboration in scientific and technical research among industries and academicians to compile and derive local emission factors based on IPCC Guidelines.

7.2.2 Mitigation

In the INC the mitigation assessment had identified certain measures, mainly in the energy sector, such as biomass waste for power co-generation, improving energy efficiency in the industrial sector, use of photovoltaic for electricity generation and demand side management of energy. Appendix 4 contains an update of the mitigation actions taken since the INC.

One of the measures is SREP as mentioned in the National Circumstances chapter, to promote renewable energy. The following barriers have been identified in the implementation of SREP:

a. Economics and Pricing: RE projects are not economically viable as the cost of RE technologies remain expensive compared to prices offered by off-takers (utilities) resulting in poor RE development. The existing RE tariff is not sufficiently attractive as prospective RE developers expect a quick payback period. However, it is quite unlikely that higher prices can be given with the current mechanism as conventional electricity prices are still low, due to subsidy pricing for gas as compared to the cost of RE generation.

b. Funding and Financing: Loan facilities from banks and the Government for RE projects are limited. Stringent bank loan requirements are imposed on RE developers. Loans that are being offered are generally for a short period with high interest rates and loan disbursements are done only after the project has proceeded to an advanced stage of construction. This is due to the perception by the banking institutions that RE projects are high risk projects.

c. Technology/Technical: Local RE technologies that are proven and efficient are limited in the market. Most developers depend on foreign technologies resulting in cost increase; and

e. Institutional Framework: RE is quite a new subject in Malaysia where there are only a small number of RE projects that are already in operation across the country. Most agencies dealing with project development approvals are unfamiliar with RE. Therefore, there is inadequate capacity in the agencies dealing with RE development which results in bureaucracy and unclear procedures for RE projects. Apart from that, the institutional structure dealing with RE is fragmented and needs to be coordinated to facilitate RE development.

With regard to PV technology using solar power, apart from high costs, Malaysia's duration of direct sunlight averaging about six hours daily due to high cloud cover also poses a barrier as it limits the electricity generation potential.

Some overall strategies to address some of these barriers have been highlighted in the next chapter (Chapter 8, Section 8.9)

With regard to this report, potential mitigation options have been described for each sector. Nevertheless, there are gaps in this analysis that need to be addressed. Table 7.1 lists the specific gaps and suggestions to be considered during the implementation of subsequent National Communications.

From the overall assessment, only the energy, waste and LULUCF sectors cover the long term scenario planning. Other than that, the factors causing the gaps were generally due to the following:

- Lack of policy instruments especially in the transport sector where at the time of this analysis, there was no relevant policy as yet to encourage change in the mode of transport from private to public or to encourage manufacture of more environment-friendly vehicles such as non-motorised transport and hybrid cars.
- Lack of appropriate data to carry out future projections in the modelling exercises. Appropriate data therefore should be collated by the relevant stakeholders.

Table 7.1
Mitigation Gaps and Suggestions

Sector	Gaps	Suggestions
Energy	• Mainly supply side for the power sector was considered • Demand side only covers industry and buildings • Only bio fuel was described – no other transport options • Other sectors e.g. residential, commercial and agriculture, were not discussed • Lack of experts in the energy modelling tools • Lack of training on energy modelling	• More demand sectors e.g. residential, commercial and agriculture should be involved. • Other transport options to be included.
Waste	• Present analysis is mainly focused on waste management in Peninsular Malaysia based on the National Strategic Plan and Waste Minimization study. • Mitigation for reduction of GHG emissions from the waste sector involves the participation of several agencies. There are still gaps and coordination issues in this regard. • Source separation is not required presently. Hence all discarded wastes are mixed at the moment. This hinders the effectiveness of implementing organic waste treatment or recycling. Furthermore, targets for recycling are normally set for inorganic waste. • Most of the existing organic waste recycling initiatives in Malaysia are small scale due to low economic feasibility and lack of incentives.	• A comprehensive roadmap for the waste sector is needed. • The benefits of implementing the Solid Waste and Public Cleansing Management Act 2007 in terms of GHG emissions should be analysed through a cost benefit analysis to obtain further support for its implementation. • Develop and implement a programme to recycle organic food waste to increase awareness in using simple composting practices. • Build more facilities for the treatment of large amounts of organic food waste. • Initiate demonstration projects on the viability of handling large amounts of recyclable wastes.
Agriculture	• Mitigation options are mainly focused on rice management, manure management and nitrogenous fertilizer management. • Preliminary analysis of mitigation benefits in future.	• Cost-benefit analysis should be included. • Projection data should be reassessed.
LULUCF	• Inability to evaluate the monetary value of forest ecosystem services.	• Comprehensive valuation of ecosystem services to enhance the competitiveness of maintaining forests as opposed to converting land to other uses.

- Financial constraint is one of the key issues that limits the study and research that needs to be done e.g. road transport target setting etc.
- Limited familiarity with using modelling tools.

7.2.3 Vulnerability Assessment and Adaptation

(i) Constraints and Gaps in Climate Modelling

Although there are already downscaled climate change projections models for use in Malaysia namely the RegHCM-PM and the PRECIS, questions on the degree of their accuracy remain. This affects the level of confidence in making recommendations and decisions. Simulation from the 9 km resolution RegHCM-PM was validated against a short duration of available observed data. The simulations of the PRECIS model at the resolution of 50km allows simulation for a bigger region, however greater computing resources need to be made available to enable higher resolution runs and a greater ensemble of scenarios to generate the required high resolution scenarios for climate change adaptation assessments with greater confidence. Confidence in these models have been carefully assessed and validated using longer and more types of observed data. One of the findings is that these models need to be modified further to reduce the uncertainties in future climate projections.

Much remains to be understood in regard to the workings of the climate system and therefore uncertainties arise due to the incorrect or incomplete description of key processes and feedbacks in the various GCMs and the downscaled regional models. This is evident by the fact that current GCMs and the downscaled regional climate models employing different representations of the climate system, though using the same emission concentration scenarios, projected different patterns and magnitudes of climate change for the same period in the future. Sources of climate simulation uncertainties also include the emission scenarios considered, future GHG concentrations assumptions used, incomplete understanding of global and regional climate system workings, natural variability and uncertainties in regional climate change. Uncertainties in conversion of emission of GHGs into atmospheric concentration result from incomplete understanding of the carbon cycle physics and chemical reaction processes in the atmosphere.

The climate varies from timescales of years to decades due to natural interactions between the atmosphere, ocean and land. For a given period in the future, natural variability could either reinforce the underlying human-induced change or could counteract it. This uncertainty cannot be removed but can be quantified by running ensembles of future climate projections of both the GCMs and the downscaled regional models.

However this is constrained by the lack of access to these models and the immense cost in terms of financial and high performance computing to run model simulations.

(ii) Constraints and Gaps in Socio-economic Impacts and Response

There are gaps and uncertainties in conducting socio-economic impact assessments. The econometric module and Input-Output (I-O) module which are proposed to be used for future assessments have their respective limitations. With the econometric module, statistical problems such as auto-correlation and multi-colinearity occur frequently influencing accuracy of results.

(iii) General Sectoral Constraints and Gaps

The gaps and uncertainties in all sectors are numerous. Most are related to knowledge and skills in V&A and the interaction of components of the various sectors. Modelling is especially needed for agriculture, biodiversity and forestry because field experiments and studies may take a long-time and may perhaps not be in time for decision making related to choices of adaptation measures. Furthermore, adaptation measures if proposed without adequate data and information may be erroneous and costly or even irreversible.

Models are also needed for inter-sectoral V&A. For example, health is also impacted by population growth, migration and changes in land use.

Limited allocation for research and development activities could impede adaptation implementation. The gaps in the level of technical understanding between different agencies result in a time lag in decision making.

Overall, whilst efforts on V&A have started amongst professionals within each sector, the affected population is still mostly unaware and not being prepared to adapt to the anticipated change.

(iv) Gaps within Sectors

a. Water Resources Sector

There is limited long-term historical data for hydrology and water resources. Also the number and frequency of hydrological and river flow data stations are still low.

Some of the on-going impact studies are independent of other areas that directly affect the main objective of the study itself. For example, presently, studies on impacts on water supply do not take into consideration competition from irrigation and non-consumptive water uses. However, such an approach may lead to selecting ineffective adaptation measures as it does not provide a complete assessment of the issue.

b. Agriculture Sector

Climate change could impact agriculture in terms of productivity and agricultural practices; and the consequent formulation of adaptation strategies. Quantifying these impacts is difficult due to uncertainties in the following: lack of local data on the magnitude of climate change, crop parameters and soil properties that are required for projections using crop models; the effects of technological changes on productivity; and future food demand.

Modelling has been carried out to assess the impact of climate change on crop development and yields on oil palm, rice and rubber. However, these projections of the impacts need to be further improved by using crop and soil parameters determined from field studies.

Experimental data on the impact of climate change on agriculture activities such as the effects of temperature and rainfall variability are relatively limited. Research including the development of baseline information and associated funding is needed.

It is also recognised that developing successful adaptation measures involves identifying and overcoming various barriers that include economic, information and social ones. In this regard, multidiscipline research involving natural and social sciences have to be carried out to develop practical adaptation measures taking into consideration the needs of various stakeholders such as farmers, agrobusinesses, policy makers and consumers.

c. Forestry and Biodiversity

Data and information on the impact of climate change on forests is at present very limited. Further research needs to be undertaken to gather more information to enable decision making in the future.

Data and information on many groups of Montane and Coastal species as well as arthropods and insects are very sparse. Data and information on how they respond to changing climate conditions is limited. The country also needs more expertise in marine biodiversity and ecosystems.

The flora and fauna requires habitat large enough to adapt to changes in their ecosystem. The current analysis deals mainly with inland habitats, higher plants and vertebrates. Data on how these ecosystems and groups respond to climate change in a tropical environment are equally lacking. There is a need to establish more totally protected areas (TPA) that capture the variation and diversity of what is found in the country.

d. Coastal and Marine Sector

Developing good local models on sea-level rise is constrained by lack of long-term tidal records. V&A for this sector requires inter-disciplinary inputs.

Studies on coral bleaching due to the increase of sea surface temperature are needed. To date, insufficient studies have been done on the impact of decreasing salinity, increasing acidity as well as the impact of temperature changes on marine organisms.

e. Energy Sector

One of the main gaps for this section is the lack of data on frequency and intensity of lightning events. Data on changes in physical oceanographic patterns due to climate change and the potential impacts especially on the oil and gas sub-sector is also lacking. Presently, there are limited R&D activities and studies on alternative construction and operation methods. Furthermore, quantitative data which is also limited is required in the design of coastal protection structures/measures for seafront facilities.

f. Public Health Sector

Little is known about how climatic factors could aggravate the impact of air pollution on morbidity and mortality rates in Malaysia. The potential impact of extreme weather on health has also not been assessed. Additionally the capacity for advanced modelling and statistical analysis is also limited.

The potential extension of brackish water ecosystems as a result of sea level rise that could increase the spatial distribution of malaria is not known. Relationships between climatic factors and disease transmission, particularly dengue, needs to be further investigated.

Updated vector distribution maps are important in assessing vulnerability and designing adaptation measures to address the spread of vector-borne diseases. Surveillance data also needs to be improved to become more comprehensive.

(v) Actions Identified to Address Constraints and Gaps

a. Seek better access to regional climate models and enhance regional partnerships in downscaling models at regional levels.

b. Improve accuracy of regional hydro-climate model projections by using more GCM models and realizations as well as river basin-based models with finer scale and temporal resolutions.

c. Conduct a water resources study for the entire country to update the data from the study undertaken in 1982 regarding water from annual rainfall and its distribution in terms of surface runoff, evapotranspiration and groundwater recharge.

d. Develop capacity building programmes to address gaps in vulnerability assessment and adaptation for relevant sectors. This should address financial, economic and social aspects of these sectors, and should address gaps in terms of education and training, development of models and ICT infrastructure as well as recruitment of experts and specialists.

e. Address research gaps in the present assessment such as sea surface temperature changes, sea acidification, impacts on marine and terrestrial biodiversity, identifying climate change indicator species and factors effecting the spread of diseases like dengue and malaria.

f. Local capacity in advanced statistical modelling needs to be strengthened to better understand dengue transmission and the influences of climatic and other factors.

g. Develop long-term wave measurement programmes along Malaysian coasts to address the lack of studies related to coastal storms, wave patterns and sea level rise over time.

h. Mainstream climate change adaptation into disaster risk management programmes and look into critical measures related to good contingency plans during extreme events. Examples of this include ensuring the integrity of major structures, and uninterrupted services of utilities (especially energy and water resources).

i. Develop an integrated programme to research priority areas such as agriculture, public health, disaster risk reduction, and also address interdisciplinary concerns and inter-related sectors.

j. Obtain new analysis methods, computer models and build capacity to advance towards a holistic and integrated approach on vulnerability assessments.

k. Future V&A assessments should be carried out using an ecosystem approach, for example, coastal, urban, flood plain or highland eco-systems, rather that through sectoral assessments. In this approach, all sectors will work together within the same eco-system to assess impacts of climate change and plan holistic adaptation measures.

7.3 Technology Transfer

The ability of the country to address the impacts of climate change in line with commitments under the UNFCCC depends on access to and availability of appropriate technologies. Most of these technologies are protected by patents or licences and require significant upfront investment. In addition, technology transfer needs to be accompanied by appropriate capacity enhancement.

For Malaysia, it is a challenge to progress to a low carbon economy without technological and financial assistance. The Prime Minister when addressing COP 15 at Copenhagen stated that Malaysia's ability to achieve the voluntary reduction of up to 40 percent in terms of GHG emissions intensity of GDP by the year 2020 compared to 2005 levels is dependent upon the amount of technology transfer and financial assistance received from developed countries. Relaxation of international policy on green technology ownership, technological transfer and technology development cooperation and assistance are vital in enabling Malaysia to address the challenges due to climate change in the near future.

The following are some of the key areas where technology transfer would provide a substantial benefit in terms of reducing GHG emissions: green technologies for (i) sustainable transportation; (ii) harnessing renewable energy; (iii) becoming more energy efficient; (iv) towards cleaner production technologies for SMEs; (iv) efficient and effective waste management; (v) methane/carbon capture and storage/use. In addition, affordable technology to implement adaptation measures is also critical. Apart from the significant and more immediate benefits of reducing the negative impacts of climate change locally, in many instances, adaptation measures also have mitigation benefits by making the nation more climate resilient, thereby reducing future recovery and reconstruction costs and related emissions.

MALAYSIA
SECOND
NATIONAL
COMMUNICATION
TO THE
UNFCCC

Chapter 8

ADDRESSING CLIMATE CHANGE

CHAPTER 8: ADDRESSING CLIMATE CHANGE

8.1 Introduction

Based on the information contained in the previous chapters, there are a number of overall measures that need to be implemented. These measures will better equip the country to handle the threats of climate change that would hinder future development, while at the same time ensuring that the country is able to identify and benefit from the opportunities that could also be presented.

A common theme that runs throughout all the thematic analysis is the lack of data or easy access to data along with the need for local capacity to be continuously upgraded and having adequate financial resources and skills to undertake climate change related research. Access to affordable and robust green technology has been identified as key in implementing measures to deal with climate change as well as transition into a low carbon economy.

The measures below are proposed as means towards greater coherence in actions to address climate change. Some are proposals whilst others have already been initiated since 2007.

8.2 Enhancing and Developing National Climate Services in Malaysia

Enhancing the national climate services would strengthen the production, availability, delivery and application of science based climate predictions and services as well as coordinate climate information for the government and stakeholders. The goals are to enable better management of risks of climate variability and change at all levels and to provide a cooperative framework for current and near term adaptation to climate change. Users are expected to benefit as this will help mobilize climate science by creating mechanisms for sharing new advances in science.

This enhancement should also include more coordinated climate research carried out among relevant agencies. It would enhance and expand the use of climate information so as to make the government's efforts to deal with climate risk management, adaptation and mitigation issues more coherent and effective. This is in line with the Global Framework for Climate Services established at the World Climate Conference-3 in Geneva, 2009, that aims to enable better management of the risks of climate variability and change at all levels through the development and incorporation of science-based climate information and prediction services into planning, policy and practice.

The climate services required for climate related risk reduction and management in Malaysia are:

a. Climate data and database, application and products for climate information to clients and stakeholders;

b. Information and predictions on climate variability such as El Niño Southern Oscillation (ENSO) and other climate fluctuations and their impacts;

c. Seasonal climate to decadal scale climate prediction;

d. Climate change projections and scenarios for impact and vulnerability assessment; and

e. Expert advice tailored to specific sectors and user requirements on climate matters.

A number of gaps identified in the current provision of climate services in Malaysia include:

a. Climate data are sparse or the lack of sufficient meteorological observation records (including sea level data) for the past and present observation;

b. The cost of instruments, communication and the maintenance of the meteorological observation system is very high along with difficulty of maintaining data quality;

c. Products from international/ world climate centres are not easy to use, and there is a lack of methodologies and tools to generate climate product applications for local use;

d. Low accuracy and skill in monthly and seasonal climate prediction based on available output from major international/ world climate centres, making it very difficult to communicate the predictions to decision-makers and users;

e. Spatial resolution of products from seasonal climate prediction is too coarse for local details and national use, therefore, the uncertainty in the prediction makes it very difficult to advise decision-makers and end users.

f. Low understanding on uncertainties and limitation of climate change projections and scenarios for effective communication to decision makers and end users;

g. Limited expertise in climate science, climate modelling and socio-economic impact assessment; and

h. Limited activities for increasing awareness of communities to climate variability and climate change issues.

The recommendations include:

a. Enhancing climate research, including modelling and prediction aspects to characterise climate variability and change and to generate quantitative climate predictions and climate projections on a range of time and space scales.

b. Enhancing capabilities in multi-hazard early warning systems and disaster prevention and preparedness by using an integrated approach to deliver multi-hazard technical capacity development and multi-sectoral partnerships and service delivery to a wide range of stakeholders to support:

   (i) Risk assessments;
   (ii) Reduction of mortality risks through early warning systems (EWS);
   (iii) Reduction of economic risks through medium to long-term sectoral risk management and planning (e.g., land zoning, infrastructure and urban development, agricultural management, health, etc.);
   (iv) Risk transfer through catastrophe and weather-indexed insurance and other financial tools;
   (v) Information/knowledge sharing and educational programmes at various levels.

8.3 National Global Climate Observation System (GCOS) Coordination

To achieve better understanding of the climate, long-term climatic information and comprehensive observation and monitoring systems are crucial. Such an understanding is important in planning to reduce the risk of adverse weather and climate related events affecting the nation and the region. Effective systematic observation and monitoring systems need to encompass all relevant agencies, users, policy makers and stakeholders. Establishing a national GCOS Committee would provide a means to enhance coordination between these different parties.

Long term climate and climate related observations and monitoring are needed for:

(i) climate change detection and attribution;
(ii) operational climate prediction on seasonal to inter-annual time scales;
(iii) research to improve understanding, modelling and prediction of the climate system;
(iv) assessment of the impacts of, and vulnerability and adaptation to, natural climate variability and human-induced climate change; and
(v) development of climate services and applications for sustainable development.

In addition, related systematic environmental, biological, ecosystem and socio-economic data and information are needed to assess human, biological, ecosystem and environmental vulnerabilities and plan actions that must be taken in various development sectors to adapt to climate variability and change.

Malaysia has built infrastructure for observations on land, at sea and in the air that measure meteorological and some environmental variables. Various agencies are responsible for making the observations for individual networks and systems.

An enhanced observation and monitoring system is necessary to detect ongoing phenomena related to climate variability and change such as the water cycle, extreme events and their impacts. This can be done by developing observation systems for critical areas and phenomena.

Observation of sensitive and fragile systems (hot spots) at local and regional levels is very important as a means of detecting early warning indicators of impacts and vulnerability towards climate change.

As with most countries, the collection of environmental, biodiversity and socio-economic data, which is largely ad hoc and not well organized needs to be better coordinated. There are a limited number of standards developed so far for observation and archiving of such data. For sector-specific information, products and services, the respective sectors should systematically collect and manage relevant data. Barriers to sharing of data among various institutions within the country and with the global research community also needs to be removed.

8.4 Water Resources Management

The management of water resources, made more complex by a changing hydrological regime as a result of climate change, needs to be based on sound policies and strengthened institutional arrangements. Reforms and initiatives are needed towards providing an adequate as well as enabling environment for the effective and efficient implementation of IWRM. A sustainable national water sector can be realized through IWRM which essentially facilitates the integration of natural and human systems that include integration of different components of water such as surface and groundwater, integration of water with related land and environmental resources and, integration of water with social and economic development. Smart partnership agreements between the states and the federal government facilitated by the National Water Resources Council (NWRC) based on IWRM principles translated into practices at the river basin level as IRBM would ensure sustainable water resources development in the form of efficient water supply services, effective management of floods and minimal pollution/degradation of the water environment.

Increasing hydrological extremes in the wake of climate change affects the function and operation of existing water infrastructure such as flood mitigation; water supply and irrigation systems; hydropower; and urban, agriculture and highway drainage as well as also water management practices. A review of current water management practices needs to be carried out as they may not be robust enough to cope with the impacts of climate change on flood risk, water supply reliability, agriculture, energy, health, and lakes/rivers ecosystems.

The incorporation of information on current hydrological and climate variability into flood, water supply and other water related management that would assist adaptation to longer-term climate change impacts is urgently required. Similarly adaptation procedures and risk management practices incorporating projected hydrological changes with related uncertainties from fine grid regional hydroclimate models needs to be developed for various governmental agencies that deal with flood mitigation, domestic/industrial water supply, hydropower generation and agricultural activities.

The ever-increasing water demand largely resolved via supply-side strategies such as increasing storage capacities, abstraction from water courses and water transfers needs to be supplemented with water demand management strategies which maximise the use of water, conserve water and recycle water. Reducing NRW and maintenance of water treatment plants and distribution pipes which are on-going not only address increasing water demand, but also bring revenue to water supply operators. An expanded use of economic incentives, to encourage water conservation holds considerable promise for water savings and the reallocation of water to highly valued uses.

Further research in innovative rainwater management is needed to explore new ways of reducing flood, drought and other climate risks in cities, towns and communities. An emerging strategy for climate change adaptation involves the change of the rainwater management paradigm, which is to collect rainwater instead of draining it away. When cities and other sprawling urban areas, where 63% of Malaysians live, are designed to incorporate this new rainwater management paradigm i.e. harvest and utilize rainwater for multipurpose uses, several physical and socioeconomic benefits/opportunities would accrue such as prevention of urban floods, supply of additional water onsite (which reduce not only energy requirements but also GHG emissions), control of non-point source pollution, restoration of hydrological cycle (infiltration and recharge of aquifers), alleviation of urban heat islands, supplementing flows of urban streams and recreation/tourism opportunities generated from the new urban waterscapes. Rural and agricultural communities could attain similar physical and socioeconomic benefits when this new rainwater management paradigm is adopted by them too.

These new thrusts for water resources management in a changing climate calls for enhanced capacity building programmes for water-related professionals and institutions and also the promotion of water awareness in all water-using sectors. Another important component is stakeholders and community involvement in water resources planning and management especially at the local level, to ensure successful implementation of new water management communication strategies and programmes.

8.5 Coastal and Marine Management

There is a need to have a systematic programme supported by appropriate legislation for the effective implementation of ISMP nationwide.

To support the ISMP, it is of utmost importance to extend the NCVI study to further assess the vulnerability of the entire Malaysian coastline. NCVI is an index to measure the vulnerability of coastal areas against relevant parameters which includes biophysical, socio-economic and environmental ones. These indices should be developed more comprehensively to indicate the vulnerability of certain localities. The resulting NCVI will then be used as an integrated tool to compliment the implementation of a more effective ISMP. For long-term measures, the Government should use ISMP to reduce future vulnerability of populations, coastal developments and ecosystems related to SLR, which is one of the parameters of NCVI.

Legislation would be required to ensure that these plans are adhered to and appropriate agencies are vested with enforcement powers. The legislation should therefore be adopted at state level as well.

Furthermore, strengthening the capacity and capability of existing centres of excellence for coastal management and research to function more effectively as a focal point should be given priority. Review of design guidelines along with operating and maintenance practices to accommodate modification of coastal and island infrastructures such as coastal bunds, seawalls, groynes, revetments, jetties, ports, harbours, marinas and coastal drainage systems should also be undertaken.

8.6 Public Health

Several climate-sensitive diseases such as vector-borne diseases and food-and-water-borne diarrheal diseases are still endemic in Malaysia. With effective control programmes and activities that are being implemented, the incidence of these diseases like malaria, lymphatic filariasis, Japanese encephalitis and food-and-water-borne diarrhea are on the decline. For malaria and lymphatic filariasis, Malaysia is working towards complete elimination of these infections as a public health problem.

The changing epidemiology of malaria and the declining immunity of the population as a result of effective control measures have rendered the rural population of all ages vulnerable to the infection. The lack of entomological data does not allow for an accurate assessment of the geographical extent of the vulnerability. Mapping of vectors by traditional entomological methods is laborious, time consuming and expensive. A new practical approach to map the mosquito vector is required. This is important not only to assess vulnerability to changes in climate but also to help programme managers identify risk areas for enhanced surveillance in order to prevent re-introduction and outbreak of malaria. In this regard the possibility of using remote sensing technology should be explored.

Practical control measures such as aedes-proofing buildings and infrastructure should also be considered to limit mosquito breeding grounds and control the spread of dengue.

Capacity in carrying out appropriate quantitative and qualitative vulnerability assessments is limited and needs to be enhanced and strengthened. This capacity building should not be at the national level only, but also at the peripheral district level so that local assessments can be undertaken.

Capacity in the more advanced and complex statistical and modelling methods is also very limited and needs to be strengthened. The number of biostatisticians in the MOH is very small and there are practically none in health impact modelling. Mathematical modelling should therefore be identified as one of the areas in health research priority and mathematicians should be employed as research officer in MOH. Academic institutions should also be encouraged to collaborate with MOH in this area.

8.7 Adopting Integrated Analysis of Measures

From the perspective of land use in town and country planning, the role of green technology in achieving low carbon cities particularly in urban areas enables the integration of the sustainable development concept by promoting mixed-land use, green buildings, accessible and connected public transportation, and development of compact cities. Consequently, the application of green approaches and technology in planning neighbourhoods and cities at all levels is to be done through implementing initiatives including public policy and development guidelines particularly the green neighbourhood index; and continuous improvement of the development plan making process.

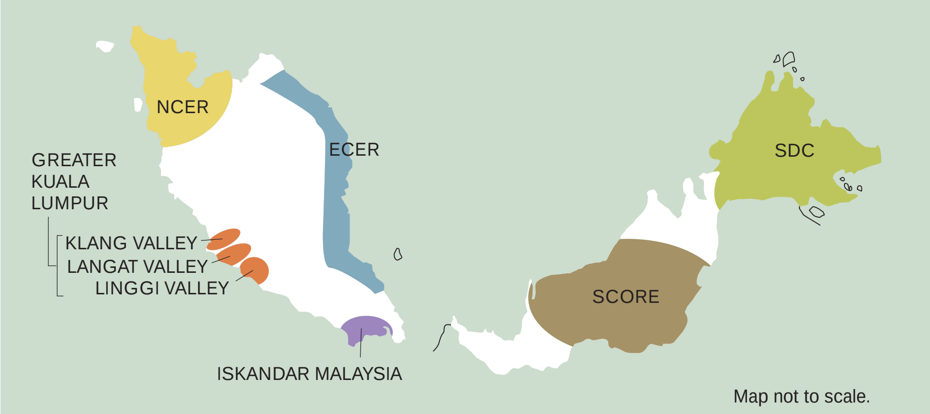
Malaysia has grouped development into regions based on the rationale of exploiting the regional inherent socio-economic strengths and potentials. This is in the form of formalising economic growth regions such as the Northern Corridor Economic Region (NCER), the East Coast Economic Region (ECER), Iskandar Malaysia and Greater Kuala Lumpur in Peninsular Malaysia, the Sarawak Corridor of Renewable Energy (SCORE) and the Sabah Development Corridor (SDC) as shown in Figure 8.1.

However, these should be revisited in light of climate change impacts and regional vulnerabilities which may invalidate certain critical development planning assumptions and consequently derail some of the pre-determined objectives and expected benefits. Hence, a key strategy would be to review the development plans taking into account potential climate change impacts and incorporate adaptation measures in an integrated and holistic manner. This may also necessitate inter-regional trade-offs and compromises to ensure sustainability in a climate change challenged environment as well as to protect matters of national interest. Vulnerable habitats that may be impacted by climate change must be kept intact as much as possible, i.e. montane and coastal habitats should be protected. Overall land use planning should be focused towards not only creating green townships but also towards developing sustainable regions.

8.8 Agriculture

Food security can be threatened by climate change impacts. While exploring new methods with R&D, traditional agricultural practices should also be revisited, revived

Figure 8.1
Economic Regions in Malaysia



and promoted.

Additionally, water management is important in ensuring food security. At the same time, it can also result in reducing GHG emissions. For example, reduction of emissions from flooded rice cultivation can be achieved through one or more cycles of drainage at mid and end season in flooded rice cultivation areas. Aerating the land greatly reduces methane emission. Drainage could be done twice; at mid season and at the grain ripening stage. This practice can reduce the scaling factor from between 0.5 to 0.2. With good rice field drainage infrastructure, this significant dual benefit of saving water and reducing emissions can be achieved in the main granary areas. More water can then be available for domestic and industrial consumption.

Nitrogenous fertilizer use results in the release of nitrous oxide, a GHG into the atmosphere. Hence strategies to reduce the use of these fertilizers should be explored and promoted. These would include the use of microbial biofertilizers. Nitrogen fixing bacteria utilise atmospheric nitrogen for their metabolism. These microbes supply nitrogen either directly or indirectly to the plants. This will greatly reduce nitrous oxide emissions. Furthermore, the reduction in the processing of synthetic nitrogenous fertilizer reduces the usage of fossil fuels and reduces GHG emissions. Educating farmers in handling microbes must be intensified as microbes are living organisms and must be handled properly to ensure their survival and functionality.

Complementary to this would be the composting of livestock manure. Aerobic handling of manure will drastically reduce methane emissions. This can be used in conjunction with the microbial fertilizers above. Composted livestock manure is needed as food for the microbes. Use of manure compost will also sequester carbon back to the soil. Composting organic household waste for use as fertiliser would also bear similar benefits while reducing methane emissions from landfills.

8.9 Energy Sector

8.9.1 Renewable Energy

Clean technology development in Malaysia is centred around RE under the Ninth Malaysia Plan, 2006-2010. The earlier four fuel diversification policy that included oil, gas, hydro and coal has been extended to include RE sources such as bio-fuel (e.g. biomass, biogas, biodiesel), municipal solid waste, solar and mini-hydro with the introduction of the Five Fuel Policy. The government has set a non-mandatory target of 350 MW grid connected electricity to be generated through RE sources by 2010, with 300 MW in Peninsular Malaysia and 50 MW in Sabah.

However, due to several barriers, as noted in the Chapter 7 (Section 7.2.2), the success rate of the programme to date has been quite low. The absence of a strong and conducive environment has prevented a sustainable RE development growth, particularly in the power sector. The existing Electricity Supply Act, 1990, which regulates the electricity supply industry is inadequate to support the growth of the RE business.

To overcome the problems and barriers of RE development in Malaysia, the Government recently approved the Renewable Energy Policy and Action Plan which is to be implemented from the Tenth Malaysia Plan, 2011-2015, onwards. The objectives are:

a. To increase the RE contribution in the national power generation mix;
b. To facilitate the growth of the RE industry;
c. To ensure reasonable RE generation costs;
d. To conserve the environment for future generations; and
e. To enhance awareness on the role and importance of RE.

The cornerstone of the Renewable Energy Policy and Action Plan is the implementation of a Feed-in Tariff Mechanism which will spur the development of RE in Malaysia. RE capacity is expected to reach 2,080 MW or approximately 11 percent of the total peak electricity demand capacity by 2020. If successful, this is estimated to avoid 42.2 million tCO_2 equivalent.

8.9.2 Energy Efficiency

EE has been incorporated as a national policy for sustainable development since the Seventh Malaysia Plan and was continued through the Eighth and Ninth Malaysia Plans. The Ministry of Energy, Green Technology and Water is in the process of developing the National Energy Efficiency Masterplan with the main objective of ensuring the rational use of energy through EE and conservation instruments. Apart from ensuring energy security, the successful implementation of this Masterplan is also expected to contribute towards a low-carbon and high-income economy.

8.9.3 Others

The government is also considering the possible use of nuclear energy for electricity generation in the future. A comprehensive study on the feasibility of this energy source for Malaysia is to be undertaken before a decision is made.

8.10 Transport

The road transport sector is one of the largest consumers of oil in Malaysia. It is therefore also one of the highest contributors to overall CO_2 emissions. A key strategy would be to improve the regulatory and socio-economic environment for public transportation to promote greater connectivity, accessibility and ultimately, usage. The existing light rail transit system in the Klang Valley should be expanded to high density housing suburbs. This concept should also be extended to other parts of the country with high density populations.

Improving public transportation has already been identified as one of the Government's National Key Results Areas (NKRA). The Public Land Transport Commission (SPAD) established in 2010 following the passing of the Public Land Transport Commission Act 2010 and the Land Public Transport Act 2010 is expected to provide a holistic solution to the public transport system in the cities. It has also been entrusted with making recommendations on planning, policies and laws to meet this objective.

At the same time, the use of technology to reduce emissions in private vehicles should also be encouraged and expanded to include available and new technologies such as hybrid, electric and hydrogen fuel cell vehicles and those powered by solar and biofuel.

8.11 Industrial Processes

Research into new processes or reducing existing processes and therefore the amount of energy and/or raw material required to manufacture that product should be encouraged through funding allocation. This would not only improve the production process by minimising wastage, but also reduce related GHG emissions. Furthermore, research into new processes could help in the development of country specific emission factors for production activities.

New processes should employ energy efficiency measures, new machine technology, automation, fuel switching and renewables. In terms of strategy, high-energy intensive industries should be targeted first as well as those industries where the energy intensity ratio is increasing to achieve greatest GHG reductions.

A road map for dealing with the specific technical steps to be taken to meet industrial emissions reduction, and guidance on the types of policies that need to be implemented should therefore be prepared and drafted within the respective government agencies to guide the transformation of industrial processes into being more sustainable in the long run.

8.12 Forestry and Tree Planting

Malaysia recognizes the beneficial role played by forests such as the protection of soil and water resources, conservation of biological diversity, fulfilling aesthetic and recreational needs, regulation of the climate system, and sequestration of atmospheric carbon, most of which have a direct or indirect role in reducing vulnerabilities to climate change and in mitigation. As such, Malaysia aims to maintain at least 50 percent of total land areas as forested areas. The following are some of the strategies employed for forest conservation and sustainable management in maintaining this forest cover, as well as enlarging green cover in urban spaces:

8.12.1 Sustainable Forest Management Practice

Sustainable forest management is the process of managing permanent forest land so that the desired forest products and services are maintained. Malaysia has developed a set of criteria and indicators for sustainable forest management. In the Permanent Forest Reserves designated as Production Forests, commercial logging is undertaken on a rotational cycle, under a sustained yield management system. Only a few mature trees (7 to 12 trees per hectare) are earmarked for felling at each rotational round of harvesting thus giving the logged over area time for recovery and regeneration before the subsequent round of harvesting.

8.12.2 Establishment of Forest Plantations

The establishment of forest plantations is essential to optimize the use of marginal or unproductive lands besides relieving the pressure on natural forests. Supply from forest plantations can supplement wood shortages from natural forests. In addition to using exotic species, suitable fast growing indigenous species are also being planted. Nevertheless, intensive management of forest plantations is essential in view of increased susceptibility to pests and infestation of diseases resulting from climate change.

8.12.3 Enrichment and Replanting Programme

In April 2010, the Minister of Natural Resources and Environment announced a nation-wide initiative to plant one tree for every Malaysian, a total of 26 million trees, in the coming five years. This amounts to an annual planting rate of 5.2 million trees per year. The areas targeted are logged over forests and poor forests and other suitable areas.

8.12.4 Urban Forestry and Tree Planting Programme

The establishment of urban forests and green spaces in cities enhance aesthetics. However, planting trees in cities, residential areas and along road sides not only achieves landscaping objectives, it also provides environmental mitigation benefits such as sound and air pollution control and local temperature regulation.

The National Landscape Department embarked on a project to plant 20 million trees between 1997 to 2020 in urban areas as part of an initiative to green cities and towns. As of 2009, a total of 10 million trees have been planted throughout the country.

8.13 Waste Management

Malaysia's efforts towards GHG emission reduction from the solid waste sector are indirect, but can be achieved through various plans and strategies outlined in the NSP and the Waste Minimisation Master Plan and Action Plan set mainly to achieve an overall effective and proper solid waste management. The focus on organic waste especially on food waste and green wastes however is still lacking. Most of the efforts in place at the moment are therefore not directly quantifiable in terms of GHG emission reduction and the cost implication is also not known. A key strategy would be to learn from the earlier 3"R" (Reduce, Reuse, Recycle) programmes that were introduced by the Government and improve on their implementation to ensure that organic and green waste are recycled.

8.14 Role of R&D

In order for wider options to be available to policy makers, R&D should be encouraged. This can be done with funds being provided for research relating to climate change and through the establishment of joint research amongst national and overseas institutions. New areas such as biofuel production, clean coal or carbon capture and storage, as well as passive, low-tech solutions such as green or white roofs should be studied to support policy making with facts. Potential vulnerabilities to climate change should be further analysed in order to provide plausible options towards climate resilience. Traditional methods and knowledge should also be collated and considered in light of the fact that they form time tested responses to challenges posed by the environment we occupy.

8.15 Role of CDM and Technology Transfer

As Malaysia progresses along the development path, all avenues to access technology to develop sustainably should be continuously pursued. Development of indigenous technology should be fostered whilst at the same time, smart partnerships should be formed with foreign counterparts to jointly develop new technology.

Malaysia's involvement with CDM should continue given the efforts already invested as well as the avenue it presents for transfer of technology. Institutions have been established to support the further development of CDM projects in the country and industries in the country are also receptive towards participating in this mechanism. Sufficient human resources and capacity are also available in the country, along with other elements such as good infrastructure facilities which make Malaysia conducive for CDM investments.

For Malaysia, the continuation of the Kyoto Protocol into its second and future commitment periods is imperative to ensure the continuity and sustainability of CDM activities which in turn provide an effective channel for the transfer of technology. The country should continue to strive to ensure that uncertainties surrounding the Kyoto Protocol and the terms of its future commitment periods are resolved expeditiously in international negotiations.

8.16 Malaysia's Climate Change and Green Technology Policies

Malaysia's National Policy on Climate Change, approved by the Cabinet in 2009, provides the framework to mobilize and guide government agencies, industry, communities, as well as other stakeholders and major groups in addressing the challenges of climate change in an effective and holistic manner. The objectives of the policy include mainstreaming climate change response through wise resource use and enhanced environmental conservation, integration of these responses into new and existing national plans and programmes, and strengthening institutional capacity, with the collective goals of strengthening economic competitiveness, improving quality of life, strengthening development resilience in the face of the potential impacts of climate change, and reducing its negative impacts. It takes as its principles, development on a sustainable pathway, including conservation of the environment and natural resources and a low carbon economy. It also emphasizes coordinated implementation and effective participation of stakeholders, and reaffirms the centrality of common but differentiated responsibilities and respective capabilities. The policy lays out 43 key actions as part of 10 strategic thrust areas to facilitate the integration of climate change considerations into planning and implementation of development programmes and decision-making processes.

The National Green Technology Policy, launched in 2009, seeks to promote low-carbon technology and ensure sustainable development while conserving the natural environment and resources. The first strategic thrust, is to establish a green technology council for high-level coordination amongst ministries, agencies, the private sector and key stakeholders for effective implementation. The second strategic thrust is to to provide a conducive environment for green technology development. This includes the introduction and implementation of innovative economic instruments, as well as the establishment of effective fiscal and financial mechanisms to support the growth of green industries. The third strategic thrust seeks to intensify human capital development by providing training and education programmes, and by introducing financial packages and incentives to students embarking on green technology-related subjects. The fourth strategic thrust is to intensify green technology research and innovation towards commercialization, with incentives to be announced in due course. The final thrust is strong promotion and public awareness especially as green technology, is a new area in the country. The government aspires to lead by example by adopting green technology in government facilities. It shall promote education and information dissemination to create buy-in from the public to support the ''green economy'' and adopt ''green practices'' as part of life.

The Government restructured the Ministry of Energy, Water and Communication and renamed it the Ministry of Energy, Green Technology and Water to support and enhance the implementation of green technology in Malaysia. In line with this, the functions of the Malaysia Energy Centre (PTM) were revamped and it is now the Malaysian GreenTech Corporation (PTHN/MGTC).

Both these policies are important in achieving Malaysia's broader development goals of achieving a high income nation status in a sustainable manner. Strategic implementation of these policies is therefore necessary. Recognising this, a National Green Technology and Climate Change Council, chaired by the Rt. Hon. Prime Minister, was established in early 2010 to foster greater ties and coordination between these two complementary areas.

8.17 Measures to Enhance Public Awareness and Participation

Strategies to enhance public awareness and participation are critical to the success of the nation in undertaking actions to address climate change. Activities by and engagement between the public sector, NGOs, the media and the business sector have been fruitful. However, while public awareness has grown due to these efforts, there is still much scope for greater public contribution through enhanced awareness.

Apart from the existing efforts, newer modes of outreach provided by developments in information technology should be explored and utilised. Tools like blogs and Facebook could act as effective mediums to reach a wider group. An added advantage is that these alternative media modes allow for interactive communication enabling feedback, so that messages can be appropriately pitched.

Additionally, engaging and collaborating with the arts community would be an effective way of enhancing public awareness. Various art forms such as the visual and performing arts, and various mediums including existing print as well as new media can be employed to creatively educate the public. The objectives of the "carrot and stick" approach to generate behavioural changes can be hastened with parallel messaging using the arts which are very effective change catalysts. For example a well curated art exhibition, catchy songs, clever cartoons or documentaries/films can impart messages in a humorous or otherwise engaging manner. This could be used to trigger self realisation regarding climate change within the populace, especially the young, who are more open to information presented in a non-didactic manner. Action generated through self realisation is generally more effective than that instigated by incentives or threats. Hence exploring and working together with artists should be adopted as a strategy to enhance efforts to change general public perception on climate change and each individual's role in addressing it.

8.18 Conclusion

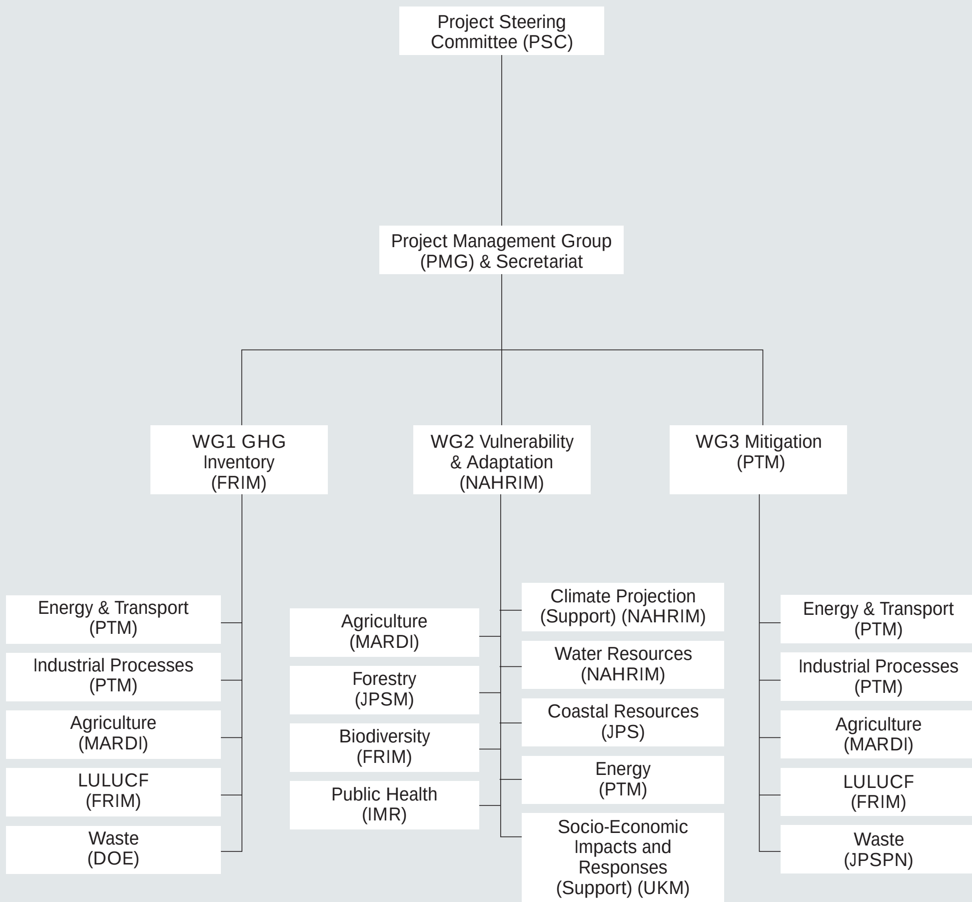
Taking stock of potential threats and opportunities regularly is critical to enable Malaysia to achieve her development aspirations. The overall measures outlined above, based on the information presented in the earlier chapters, are intended to steer the nation towards greater resilience in the face of climate change without compromising on developmental goals.

The success of these strategies is dependent on a mixture of internal and external factors. Internally, the role of government to promote behavioural changes of Malaysians should be further enhanced and developed in collaboration with other stakeholders like NGOs and the private sector to enhance the effective utilisation of energy, water and all natural resources in a sustainable and efficient manner. Concurrently, institutional capacities and strengths should be further explored and tapped to achieve the necessary levels of synergies to plan and implement holistic and integrated strategies to adapt and mitigate. In this regard, there has already been some encouraging progress recently in terms of policies and initiatives to promote green, cleaner, low carbon and climate resilient sustainable development. The announcement during COP 15 to adopt an indicator of limiting the emission intensity of GDP on a voluntary basis is regarded as an important driver of the climate change agenda in the country as well as the recognition of sustainability as one of the three key pillars of the recently announced New Economic Model (NEM).

Externally, provision of adequate and timely access to technology and financial resources along with the enhancement of national capacities, would offer some of the more critical means of achieving these strategies. In this regard, the importance of developed countries honouring their international obligations cannot be overemphasised. Aspirations towards climate resilient and low carbon growth of developing countries such as Malaysia are premised upon these obligations being met. International cooperation is needed to ensure sufficient adaptation and avoid maladaptation in developing countries. At the same time, given that climate change recognises no boundaries, sufficiently strong targets and measures to curb GHG emissions domestically must be taken by developed countries.

Malaysia therefore has to be poised to secure both these important elements of internal and external factors to progress on a sustainable growth path while developing in a carbon constrained world.

APPENDIX 1
NC2 Organisational Framework



APPENDIX 2
Key Data

	2000	2007
Latitude	99.5°E and 120°E	
Longtitude	1°N and 7°N	
Area	329,750 km^2	
Coastline	4800 km	
Mean daily temperature	26-28°C	
Average annual rainfall	2000-4000 mm	
Average daily direct sunlight	6 hours	
Forest Cover as % of total land area	56%	55%
Population	23.5 million	27.2 million
Population density	71/km^2	82/km^2
Female life expectancy	74.7	76.4
Male life expectancy	70.0	71.5
GNI/capita (2000 constant prices)	RM 13,939	RM 17,773
GDP (2000 constant prices)	RM 356,401 million	RM 506,341 million
Energy Demand	29,699 ktoe	44,268 ktoe
Length of roads (Federal and State)	65,445 km	117,711 km
Motor vehicle registration	10.6 million	16.8 million
Ridership on urban rail network (passenger journeys)	92.1 million	168.6 million
Oil Palm	3,376,700 ha	4,304,900 ha
Rubber	1,344,400 ha	1,247,400 ha
Paddy	698,700 ha	674,400 ha
Cattle	733,892	796,550
Swine	1,807,590	2,027,561
Marine Landings	1,271,511 t	1,381,424 t
Aquaculture Production	167,894 t	268,514 t
Solid Waste* (year)	16,200 t (2001)	19,100 t (2005)

* Peninsular Malaysia only

APPENDIX 3
Summary of Constraints and Recommendations

Thematic Area	Constraints	Recommendations
GHG Inventory	Lack of institutional framework and mandate for inventory work.	Institutionalise processes established during the NC2 process.
	Lack of understanding / information on processes and their resulting emissions.	Enhance national capacity with technical assistance, especially on the requirements of new inventory methodologies and performing uncertainty analysis.
	Data segregation not compatible with IPCC requirements.	Prepare a detailed plan to improve data collection.
	Lack of activity data and local emission factors.	Enhance research.
	Lack of historical data.	Enhance research to identify alternative data sets.
Mitigation	Energy analysis focussed on power supply side. This is partly due to the lack of policy instruments especially in other key areas like transport.	Include more demand side analysis (residential, commercial and agriculture) and identify other options especially from other key sources like the transport sector.
	Waste analysis based on projections for Peninsular Malaysia only and derived from inorganic waste recycling targets.	Prepare a thorough analysis for Malaysia which includes comprehensive data on landfill waste composition and a cost benefit analysis on GHG reduction potential from waste management.
	Agriculture sector describes preliminary potential options.	Study costs and benefits of these options and analyse them in relation to existing policies on Agriculture.
	Inability in the LULUCF analysis to evaluate the monetary value of ecosystem services.	Enhance efforts towards a comprehensive valuation of ecosystem services for more accurate comparison of different land uses.

table continues…

V&A	General uncertainties surrounding results from climate projection models. This NC2 analysis used results from two downscaled models only. This is insufficient to provide a high degree of confidence on the accuracy of future climate projections.	Seek cost effective access to more RCMs/GCMs, foster regional co-operation on climate modelling and downscale more RCM/GCM models for a higher degree of confidence on expected future climate for Malaysia/ the region.
	Sector/sub-sector based approach applied. However the analysis could be incomplete as it doesn't account for other contributing factors from other sectors/areas.	Given that detailed information at sectoral/sub-sectoral level is now available, future analysis should progress to a holistic and integrated approach based on a regional or an eco-system approach.
	Local research and studies on climate change impacts lacking such as effects of sea temperature rise, decreasing salinity and increasing acidity on marine organisms, frequency and intensity of lightning, air pollution and resulting morbidity/ mortality rates.	Enhance local capacity and encourage climate change related research and studies.
	Socio economic impacts analysis preliminary and only considered for coastal and marine sector as part of the NCVI.	Extend analysis to all sectors for a more comprehensive understanding of impacts; vulnerabilities; and adaptation costs and benefits.
	Due to the general gaps identified above, only "no-regrets" adaptation measures can be implemented immediately. Others, especially those involving major infrastructure changes, serve to point to areas which must be further studied in detail prior to implementation to avoid the creation of costly white elephants.	Adopt a step by step approach towards implementing adaptation measures. In future analysis, priorities and timelines for implementation of recommended measures should be considered.

APPENDIX 4
Update On Mitigation Activities since the Initial National Communication

No.	Recommendations	Status
1.	**Comparative Studies on Carbon Sequestration Potentials** Growing of trees and reforestation programmes help to mitigate impacts of climate change. To find out the extent of the benefits of reforestation and afforestation activities in Malaysia, a series of comparative studies between forest ecosystems and plantation forests with special reference to oil palm, rubber and *Acacia mangium* has been carried out. The results from these studies will enable a baseline of information on potential sequestration of carbon in different ecosystems.	In the NC2, an attempt is made to project change in forest cover, and resulting carbon emissions between 2008 and 2020. The resulting projections would represent the 'business as usual' or baseline scenario. In addition, several mitigation scenarios are generated representing a range of mitigation options. The results of the projections are presented, together with some analysis of the mitigation and opportunity costs and potential returns from carbon credit investments.
2.	**Energy Efficiency in the Transport Sector** It is necessary to conduct a study to evaluate the energy demand and supply balance in the transport sector. Better efficiency in the transport sector also means reduced pollution from exhaust emissions.	There is not much change with regard to the transport sector in Malaysia. Much of the energy for transport is still derived from fossil fuel. Below are some mitigation initiatives with emphasis on renewable energy: a. The use of compressed natural gas was originally introduced for taxis and airport limousines during the late-1990s, when new taxis were launched with CNG engines while taxi operators were encouraged to send in existing taxis for full engine conversions, reducing their costs of operation. To improve public transport in the center of Kuala Lumpur, an electric train transport system has been introduced: a. KTM Komuter is an electrified commuter train service first introduced in 1995, catering especially to commuters in Kuala Lumpur and the surrounding suburban areas. b. The Malaysian capital also has a new metro system i.e. Kuala Lumpur's light rail transit (LRT) system, comprising of STAR (Sistem Transit Aliran Ringan Sdn Bhd) and PUTRA (Projek Usahasama Transit Ringan Automatik Sdn Bhd) and the KL Monorail . In terms of bus service, the Rapid KL and Rapid Penang services run by Prasarana have improved connectivity.

table continues…

	Improvement in energy efficiency and energy efficient technologies 1. Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP) In 1999, the government of Malaysia initiated the MIEEIP to improve the use of energy in the industrial sector, with support and funding from the United Nations Development Programme (UNDP), the GEF and the private sector. Objectives: • To reduce the barriers to industrial EE and conservation through creating a sustainable institutional capacity • To increase awareness in EE • To develop policy, planning and research framework It specifically developed strategies to reduce emissions from industrial energy consumption by 10 percent by year 2007.	Some MIEEIP activities have had some impacts on recent policy formulation that is reflected in the energy chapter of the Ninth Malaysia Plan 2006-2010. Energy savings: 3.2 million GJ per year. Direct CO_2 emission reduction in audited industries: Annual: 181,000 tCO_2 Cumulative: 1.81 million tCO_2 (10 years period) Indirect CO_2 emission reduction (250 industries): Annual: 9447.7 $ktCO_2$ Cumulative: 9.45 million tCO_2 (Source: FINAL EVALUATION MIEEIP, 2008)

table continues…

	Renewable energy for power generation 1. Biomass for Generation and Co-Generation Project (BIOGEN) This project was launched on 18 October 2002 to promote biomass-based electricity generation. Objective: To reduce the growth rate of GHG emissions from fossil fuel fired combustion processes and to develop and exploit the energy potentials of biomass waste through the planting up of power generating capacity by using cogeneration technology. 2. Small Renewable Energy Power (SREP) Programme Under the SREP Programme, the utilization of all types of RE sources, including biomass, biogas, municipal waste, solar, mini-hydro and wind, are encouraged. Maximum capacity of small Renewable Energy plant designed for sale of power to the grid must not exceed 10 MW. 3. MBIPV (Malaysia Building Integrated Photovoltaic) Technology Application Project (2005 – 2010) Objective: To reduce BIPV technology cost in the Malaysian market and to generate widespread BIPV applications by creating a sustainable BIPV market in Malaysia.	The 2005 report shows 52 projects have been approved, 22 projects used biomass as the fuel source, of which 19 of them used palm oil wastes, and the other 3 projects used rice husk, wood residue and municipal waste. In addition to the above biomass-fuelled projects, there are 4 landfill gas projects and 26 mini-hydro projects. Currently, only 6 SREP developers have requested for and been given licenses to proceed with the implementation of their projects. Two of the SREP projects have been commissioned and connected to the national grid. (Source: www.ptm.org.my/biogen) Annual CO_2 reduction (2008 Value): 471.4 tCO_2/year reduction (at 0.63 tCO_2/MWh) from 818 kWp grid connected. PV systems installed capacity (213 kWp already commissioned). Cumulative CO_2 reduction (2008 Value): 787.6 tCO_2 accumulated reduction (at 0.63 tCO_2/MWh) since the start of the project, from 213 kWp BIPV systems in operation and additional 605 kWp BIPV systems awarded. (Source: www.mbipv.net.my)

table continues…

3.	Demand Side Management	Four programmes have been initiated to improve demand management. 1. Energy Efficient Motors The Energy Commission has conducted campaigns for the promotion of the utilization of high efficiency motors by the industrial and commercial sectors. Seminars and workshops, printing of brochures and flyers, mini exhibitions, press conferences, and media coverage are the activities carried out by this commission. 2. Energy Efficient Refrigerator The Energy Commission has conducted several promotional programmes on energy labelling and energy efficient refrigerators for the residential sector. As for the output, they have come out with energy efficiency star ranking system (1 star to 5 stars) for labelling purposes. For example, the refrigerators are star-rated, ranging from the least Energy Efficient to the most Energy Efficient. Approved Refrigerator brands With 5-Star Rating: SHARP, PANASONIC, and TOSHIBA 3. Labelling of Electrical Appliances Among activities that have been done under this programme are the labelling of electrical appliances to ascertain their efficiency potential and making compulsory the use of high efficiency motors in the industrial sectors. Efficient Management of Electrical Energy Regulations 2008 [P.U. (A) 444] has been gazetted on 15 December 2008. 4. E-benchmarking The government has directed all government agencies to reduce their energy consumption by 10 percent in their premises by the year 2006. The Energy Commission has collaborated with the Department of Public Works to concentrate on energy management in buildings through e-benchmarking. The building energy benchmarking tool, together with its manual has been prepared to allow consumers to compare their building energy index in $kWh/m^2/year$ with other buildings in the data base.

table continues…

4.	Transportation Biofuel utilisation for vehicles in year 2006.	The 2006 National Biofuel Policy is designed to pave the way for extensive development of the biofuel industry. All government vehicles are mandated to use the mixture of 5 percent of palm oil and diesel in year 2010.
5.	CDM	The first batch of applications for host country approval was received at the end of 2002. Projects in the pipeline can be grouped in the following categories:- Agriculture (Composting), Energy Efficiency, Landfill Gas to Electricity, Landfill Gas Flaring Reduction, Manufacturing Industry, Renewable Energy (Biomass), Renewable Energy (Biogas), Renewable Energy (Hydropower) and Animal Waste. Potential volume: 17,800,000 CERs by 2010.

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This NC2 is based on the knowledge and expertise of many local scientists, experts, individuals from various government agencies, research organizations, non-governmental organizations and universities. Each sector and thematic group held meetings and workshops with this wide range of stakeholders who willingly cooperated and contributed. The information was then compiled into background sector reports and thematic synthesis reports from which most of the information presented in this NC2 has been extracted. Several meetings were conducted to prepare the NC2 and reviewers were appointed to consider the entire report before its finalisation.

The invaluable contributions of all the stakeholders are gratefully acknowledged. Due to space constraints however, only those involved in managing the various groups and preparing the NC2 are mentioned below.

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Tribute To The Late Mr. Chow Kok Kee

Mr. Chow Kok Kee, or more fondly known as Chairman Chow in the climate circles for his capability of catalyzing agreement among parties, suddenly passed away on 9 August 2009.

He was a principal Malaysian delegate involved directly in the negotiation of the UNFCCC and its Kyoto Protocol. He served as Chairman of the Subsidiary Body on Scientific and Technological Advice (SBSTA) of UNFCCC from 1995 to 1997 and as an alternate member of the Executive Board of CDM from 2001 to 2004. As the Director General of the Malaysian Meteorological Department (MMD) from 2001 to 2005, he served in several international organizations, including as member of the Executive Council of the World Meteorological Organization (WMO) and Chairman of the ESCAP/WMO Typhoon Committee. After his retirement in December 2005, he continued to serve in the Expert Group on Technology Transfer (EGTT) of the UNFCCC. He was the Chair of the EGTT for 2007.

Amongst his many noteworthy achievements in international climate negotiations that did Malaysia proud were chairing the negotiating group that drafted the modalities and procedures of the Kyoto mechanism after the Kyoto Protocol was adopted and being the architect of the technology framework that was adopted in Marrakesh in 2001. He is recognised and remembered for his sense of fairness in his pursuit of an effective outcome as highlighted by US climate negotiator, Elmer Holt.

Mr. Chow was a ready source of knowledge and information which he shared most willingly in the NC2 process. His enduring passion and commitment to the climate cause served as a great inspiration in this process.

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